Iron and Steel ENGINEER

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FEBRUARY, 1959

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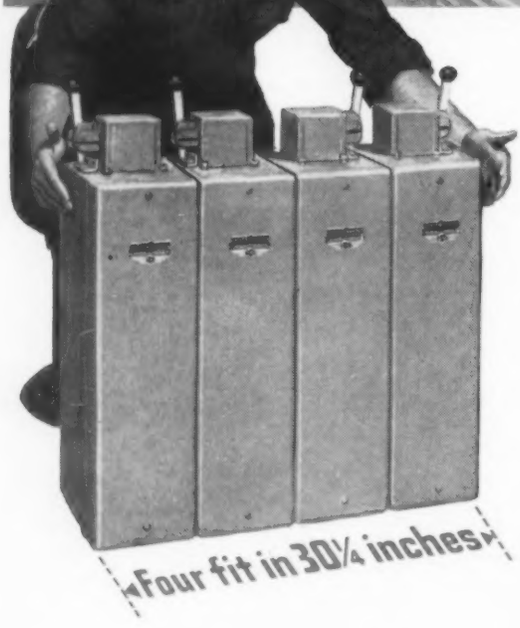

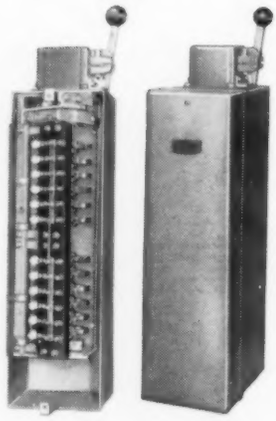

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at High Speeds Need Rugged Equipment

Higher and higher speeds and lighter and lighter gauges in tin plate put a greater and greater demand on equipment. High-speed Continuous Processing Lines must be more rugged than ever before to stand up to 21-turn operation. Our experience with processing lines dates back to the earliest production of strip in coils. In those years and today, ruggedness of equipment has been a trademark of Aetna-Standard.

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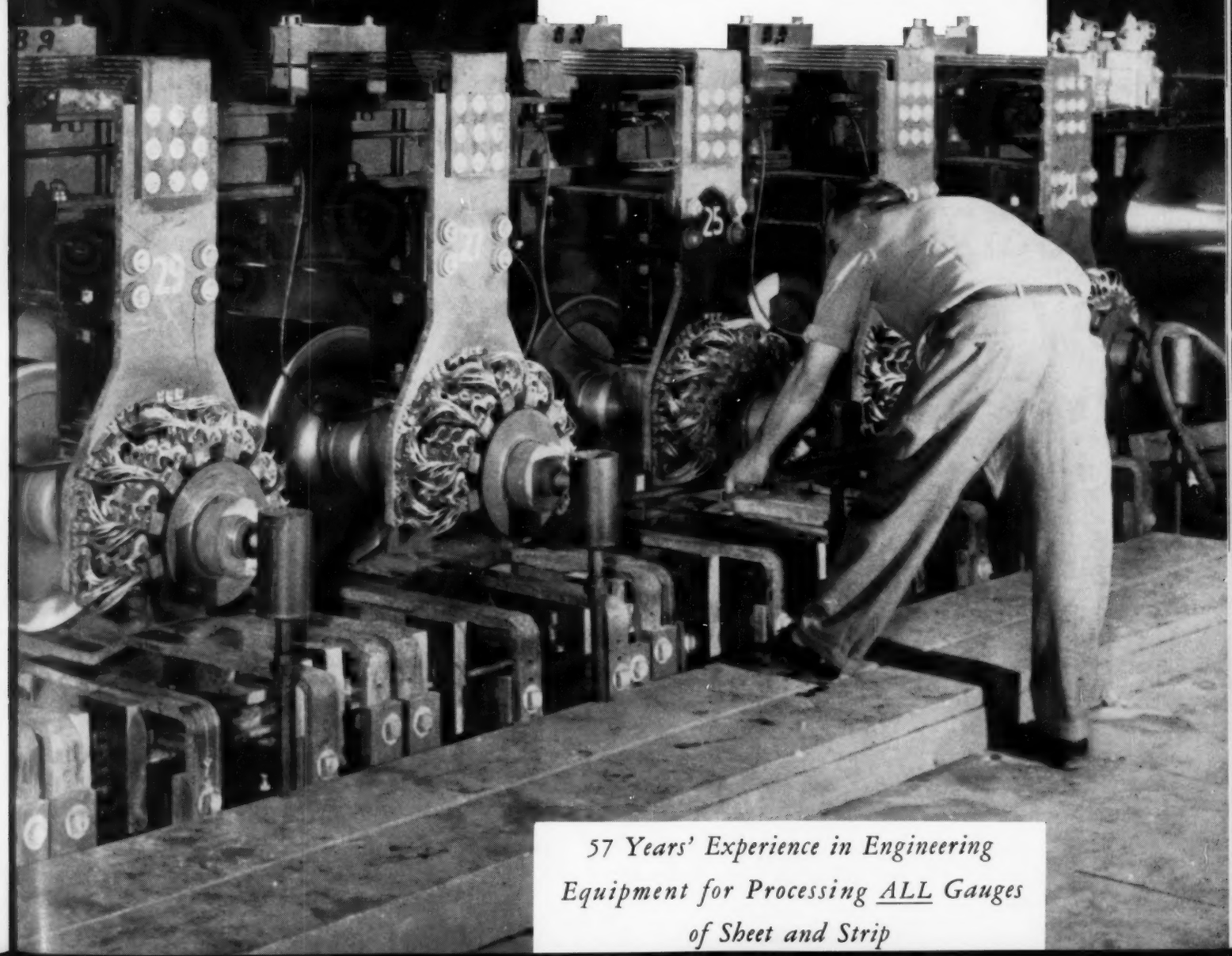

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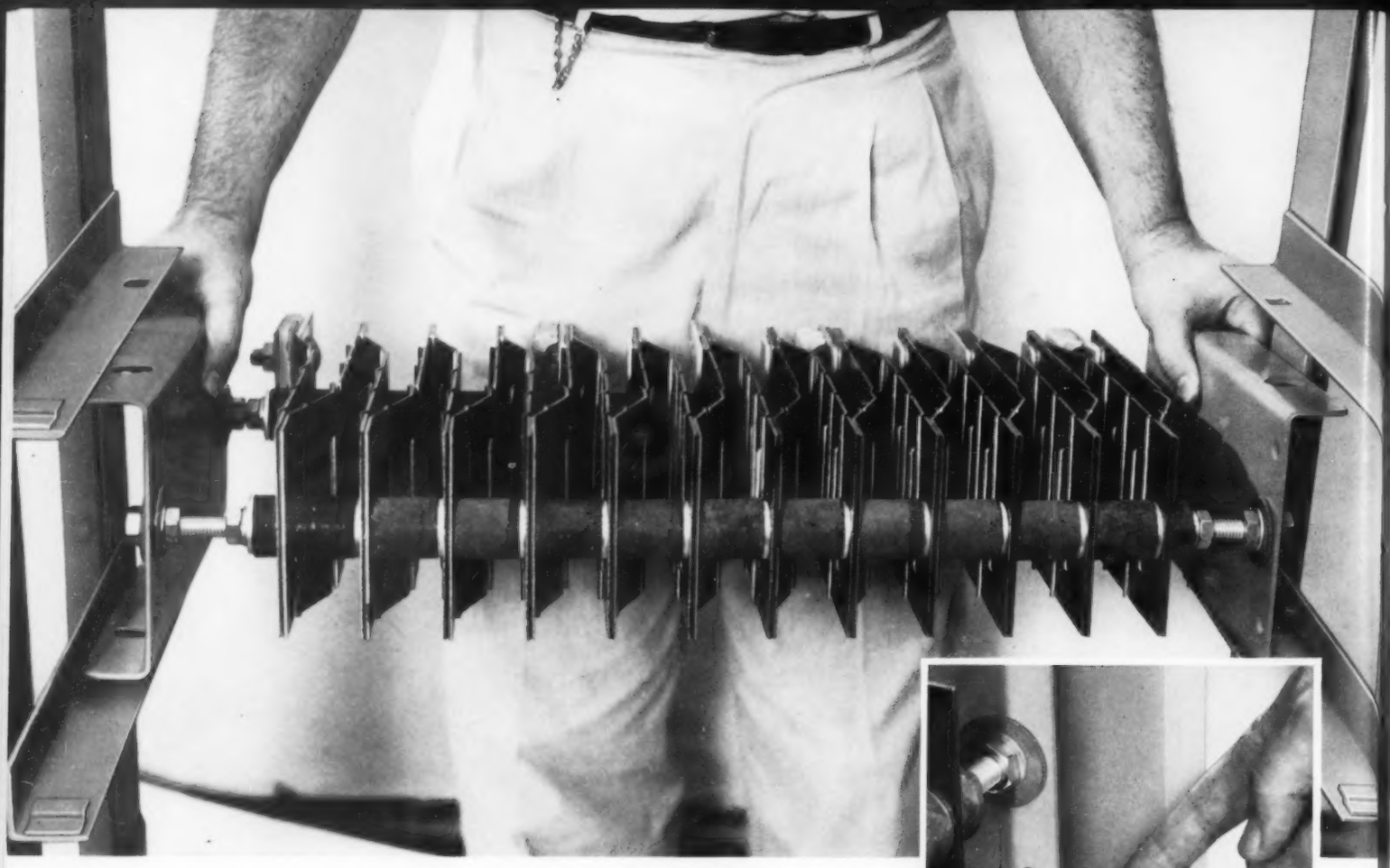

DRAW-OUT CONSTRUCTION means fast, easy resistor installation. Runners on the mounting frame guide lightweight resistor boxes into position.

CLIP LOCK at back of runner guide, plus easily accessible carriage bolts in front, hold box securely in position.

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Designed for fast, low-cost installation

General Electric's new punched steel grid resistors are specifically designed for fast, economical installation. Draw-out construction, clip locks, special grid paralleling and all-purpose terminals all combine to reduce costly installation time.

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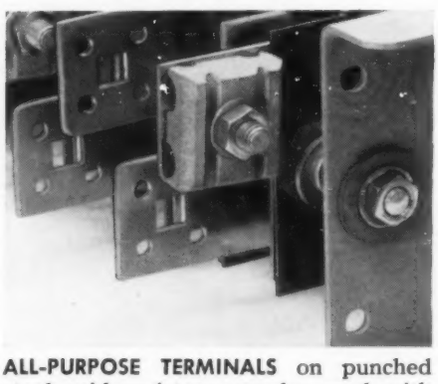
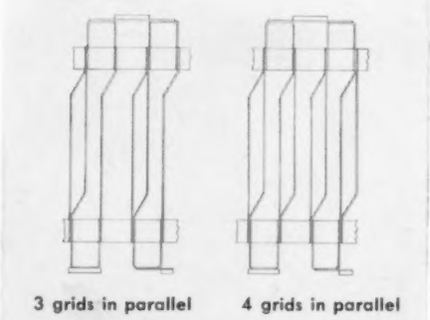
For detailed information, contact your G-E Sales Engineer, or write to Sect. 784-15, General Electric Co., Schenectady, N. Y., for bulletin GEA-6858. Industry Control Department, Roanoke, Va.



ALL-PURPOSE TERMINALS on punched steel grid resistors can be used with many wire sizes—as well as bus.



UNIQUE GRID PARALLELING allows ratings to 740 amps per box. Parallel connections are made at factory.

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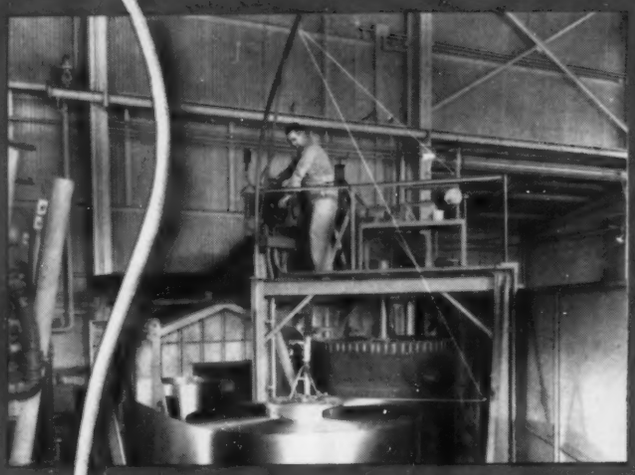

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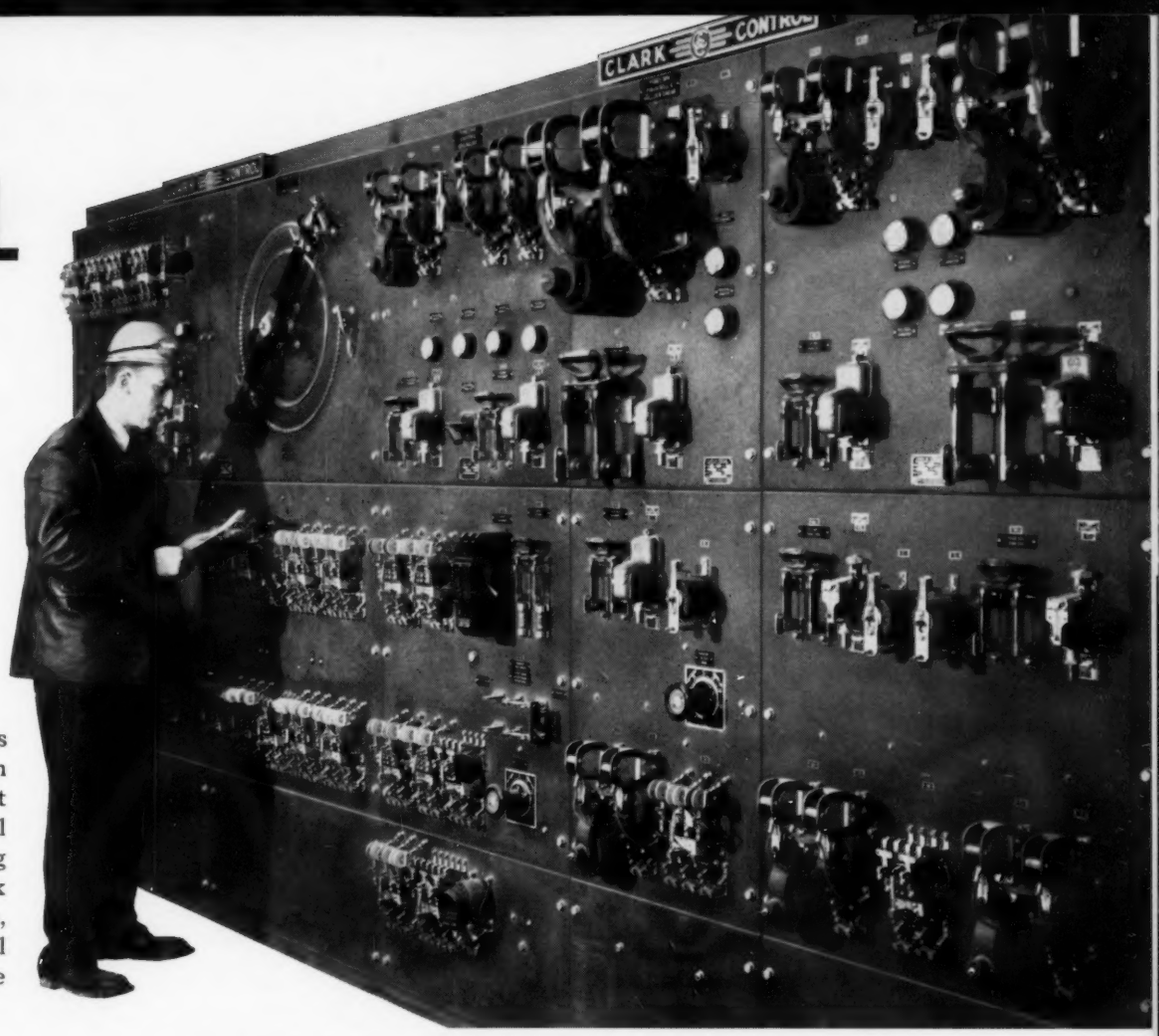
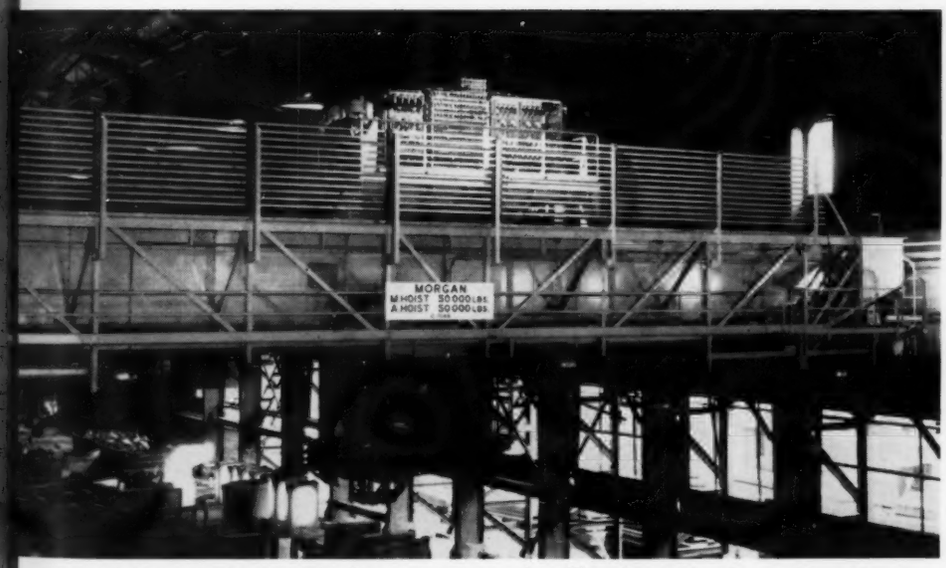
CLARK CONTROL

at the exciting new J&L

At the Cleveland Works Division of Jones & Laughlin Steel Corporation—as at other J & L mills, many vital processing and handling operations rely on Clark apparatus for dependable, low-maintenance electrical control. A few of them are shown here.



Clark Control panel for Wean Shearing Line in the finishing and shipping department.



One of three Clark-controlled Morgan Cranes handling ingots in the soaking pits area. This crane has six controlled motions: Bridge, trolley, hoist, auxiliary hoist, rotation and grip of tongs. Clark control panel is visible on top of crane.

The Old and the New. Many years ago Clark installed the controls shown in right foreground on an old stripping crane, now not in active use. A section of the Clark Control panel on the recently installed Morgan Soaking Pit Crane shown at left, is in the background above.

Jones & Laughlin is another example of a steel mill where critical operations are successfully controlled by Clark-engineered apparatus. Let us help you solve your control problems.

The **CLARK CONTROLLER** *Company*

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Regardless of size or capacity of handling problems, ALLIANCE should be there.

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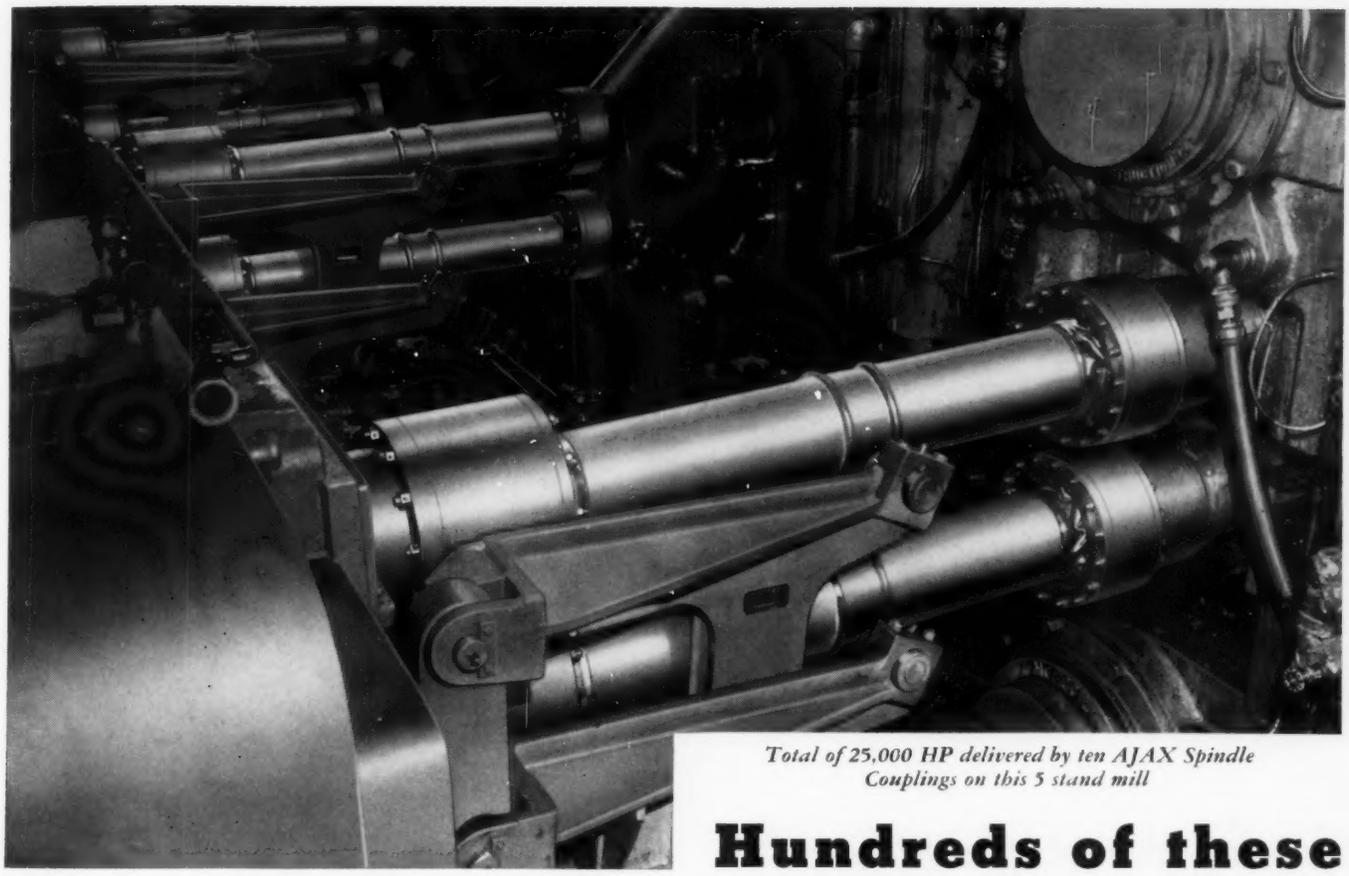

Total of 25,000 HP delivered by ten AJAX Spindle Couplings on this 5 stand mill

Hundreds of these AJAX DIHEDRAL SPINDLE COUPLINGS have been in service for 3 years

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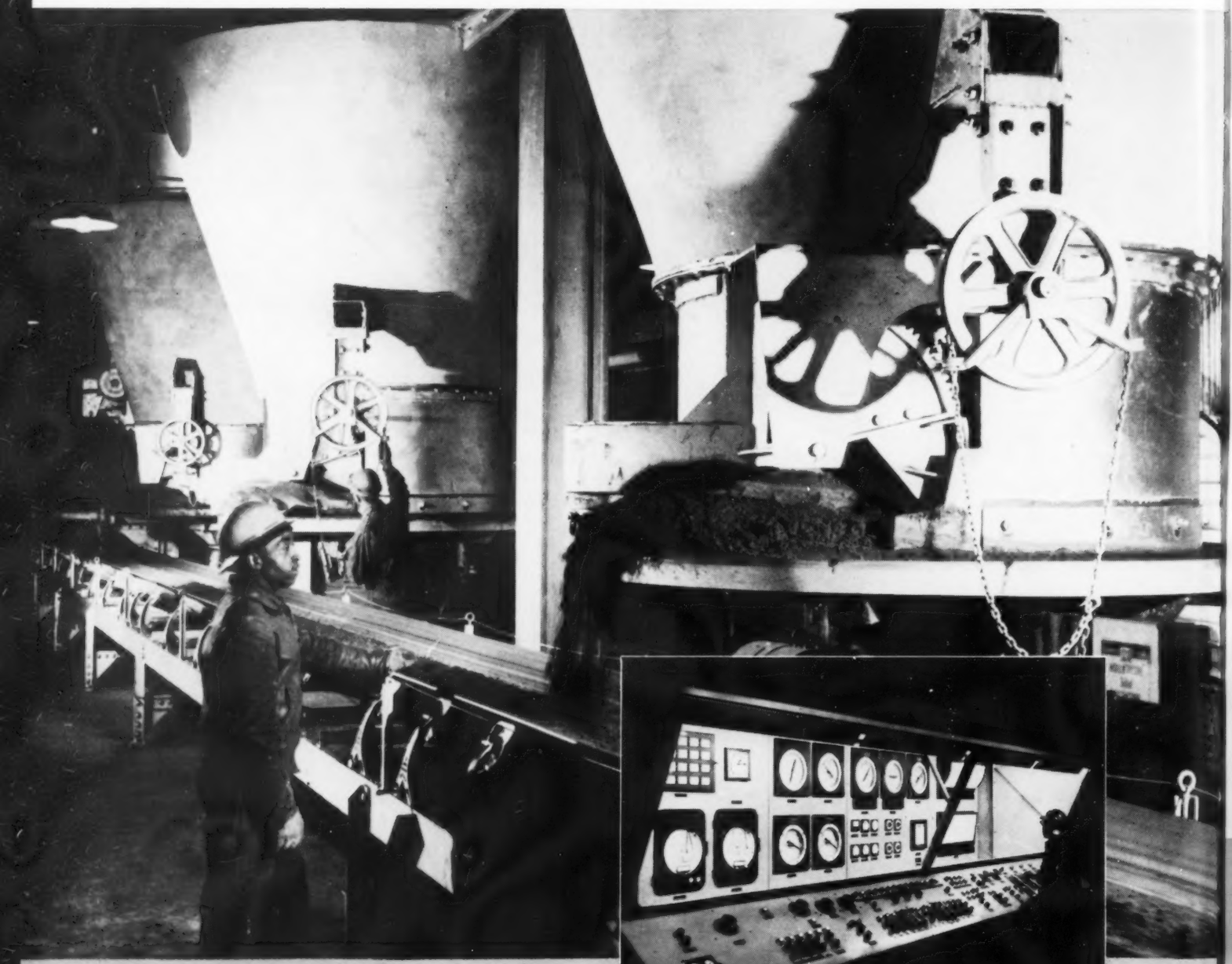
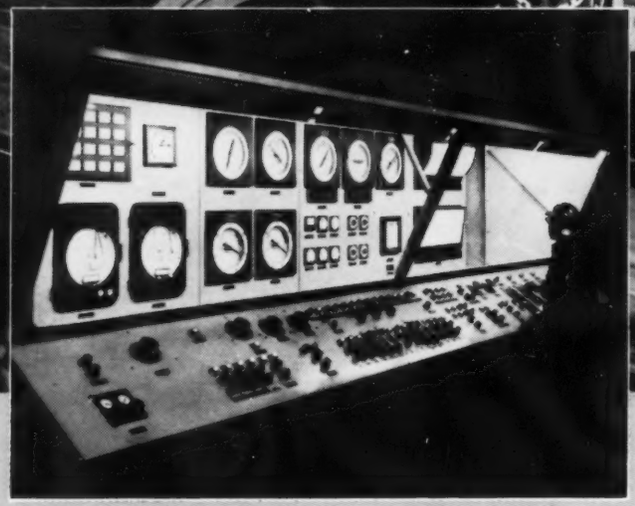


Belt-Meters by Trans-Weigh provide electrical signals to regulate the rotational speed of the feeder disc under a hopper at the new Jones & Laughlin sintering plant. The plant was designed and engineered by Arthur G. McKee & Company, Cleveland.



HONEYWELL INSTRUMENTS are pictured on the master weighing and proportioning control panel and console. Seven of the indicator-recorders shown here, and three behind the console, measure the weight of materials moving on belts—some of them transmitting signals for automatic control of materials flows.

proportioned at Jones & Laughlin plant

Honeywell *instruments control continuous process*

There's no time out for weighing materials at Jones & Laughlin Steel Corporation's 2,500 ton-per-day sintering plant in Cleveland. An automatic system weighs iron ore fines, coke breeze and flue dust, and feeds them in exactly right amounts to the sintering machine. The *Belt-Meter*® system, supplied by Trans-Weigh Company, King of Prussia, Pa., features a continuous electrical weighing technique and uses Honeywell instruments to control and proportion flow rates of materials as they move along a short section of belt.

The system is comprised of three main parts: (1) an electric tachometer to measure belt speed, (2) an electric strain gage load cell to measure belt load, and (3) an *ElectroniK* potentiometer to indicate and record flow of materials in tons per hour. In addition, a magnetic amplifier controls flows from table feeders. Twelve automated weighing units check materials as they move through every important phase of the sintering process. Operators can vary ratios and switch to manual control when desired.

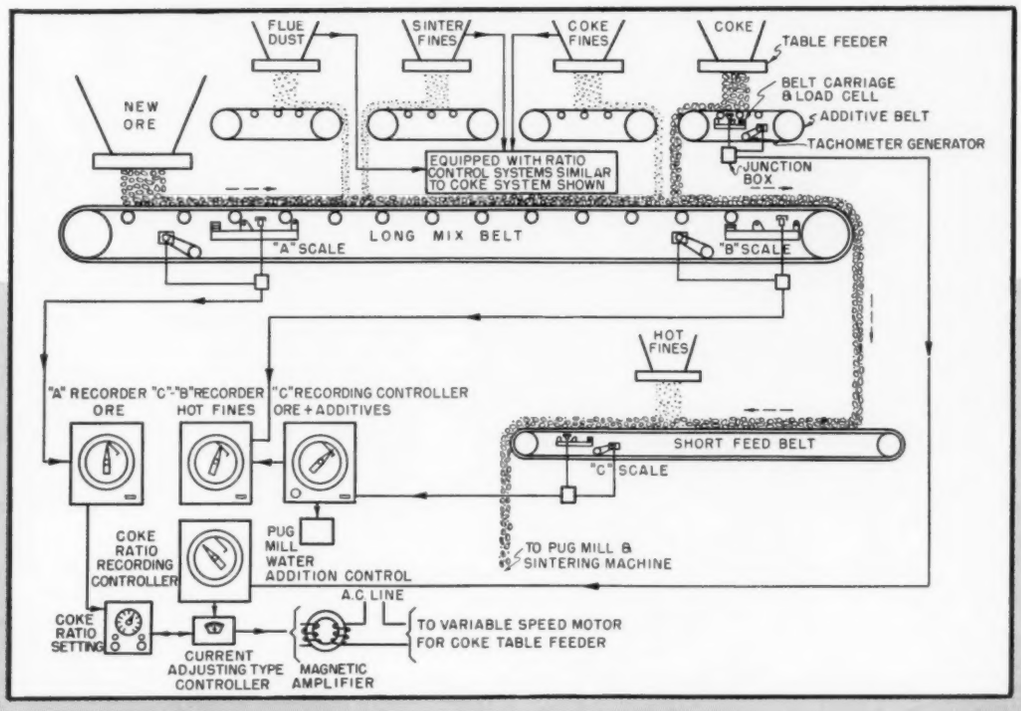
You'll find Honeywell instruments controlling virtually *every* type of process in the modern steel mill . . . improving productivity, keeping quality standards high, and bringing important day-to-day economies. Your nearby Honeywell field engineer can help you gain these advantages in your own plant. Call him today . . . he's as near as your phone.

MINNEAPOLIS-HONEYWELL, Wayne and Windrim Avenues, Philadelphia 44, Pa.

Honeywell

First in Control

COKE RATIO SYSTEM is depicted by this diagram. Three other similar integrated systems proportion sinter fines, coke fines and flue dust. Water addition to the pug mill is also controlled by a *Belt-Meter*.



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FOR
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MODERN ALL-WELDED STEEL MILL CRANES
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Crops *and* Shorts

Δ A booklet published by the Brookings Institution, "Can Inflation Be Controlled," concludes: "There is thus no simple control device by which a long-term rise in the general level of prices may be prevented. So long as the amount of money disbursed into the channel of circulation is governed by rates of remuneration for services rendered, the only effective point of control would be at the wage bargaining counter. . . . Unless the ratio of wage rates to productive output is held stable, prices will inevitably rise."

The study emphasizes some previous conclusions: ". . . gains accruing from technological advances should be divided three ways: (1) a portion should go to labor in the form of wage increases—as reward and as incentive; (2) a portion should go to business managers and stockholders—as reward and to provide funds for further expansions; and (3) a portion should, by means of lower prices, accrue to the general public. . . ."

Δ The Wall Street Journal says that men usually meet expenses when their wives introduce them.

Δ An official of the American Hotel Association announced that gross annual sales of hotels for 1958 will approximate $2,677,000,000, about 2 per cent under 1957. Yet room occupancy was 67 per cent in 1958, 70 per cent in 1957, a drop of 4½ per cent. This would indicate that prices had gone up only 2½ per cent, but from what we've seen lately we'd have guessed the increase at least two or three times that.

Δ An interesting figure also brought out in the hotel report showed that hotels built in 1958 cost $23,000 per room, motels $14,100 per room.

Δ And speaking of hotels, isn't it funny how a man wants home atmosphere in a hotel and hotel service at home.

Δ Several times on this page, we've mentioned how universal credit cards raise prices and how some western restaurants were tacking five per cent on bills so charged. The latest wrinkle, again from the West, is for the restaurant to accept the charge and bill the customer direct, thus avoiding the five to seven per cent service charge of the credit organization. If there should be any difficulty in collecting, the charge is then sent to the credit organization.

Personally, we like the idea of adding five per cent to bills that are charged. That means that the users of the service, and not us cash customers, pay for it.

Δ One of our contemporaries says he remembers when "extras" were special papers he used to sell, instead of miscellaneous items which boosted the prices of steel and autos.

Δ Preliminary earnings reports for 1958 in the iron and steel industry run the gamut from red ink in a few cases to about 8.7 per cent of sales. Major producers seem to fall between 4.25 and 8.7 per cent.

Δ Those who still think we're in a recession should remember that personal income dropped only 1½ per cent during 1958—and the total output of goods and services in the last quarter of 1958 attained an annual rate greater than in any quarter of 1957.

Δ The iron and steel industry plans to spend more than $1,000,000,000 in 1959 for new equipment and construction. This is a drop from the 1958 expenditure of $1,200,000,000 but is still better than the average of the 13 postwar years, which totaled something over $11,000,000,000.

Δ The average hourly payroll cost for wage earners in the iron and steel industry has now crept past $3.31, not including about 33 cents per hour spent for pensions, unemployment benefits, social security and insurance.

Δ T. F. Patton, president of Republic Steel Corp., says that early developments this year indicate that 1959 will be a good year for business and industry. He puts 1959 ingot production just under 110,000,000 tons.

Δ United States Steel paid out $375,000 during 1958 in the corporation's employee suggestion plan. In the 12-month period, 20,190 employees submitted 51,285 suggestions, of which 11,550 were adopted. Some others are still under consideration. Two blast furnace employees at Gary Works shared a $32,000 award.

Δ Changing Times says the up-to-date house has wall-to-wall carpeting, wall-to-wall windows and back-to-the-wall financing.

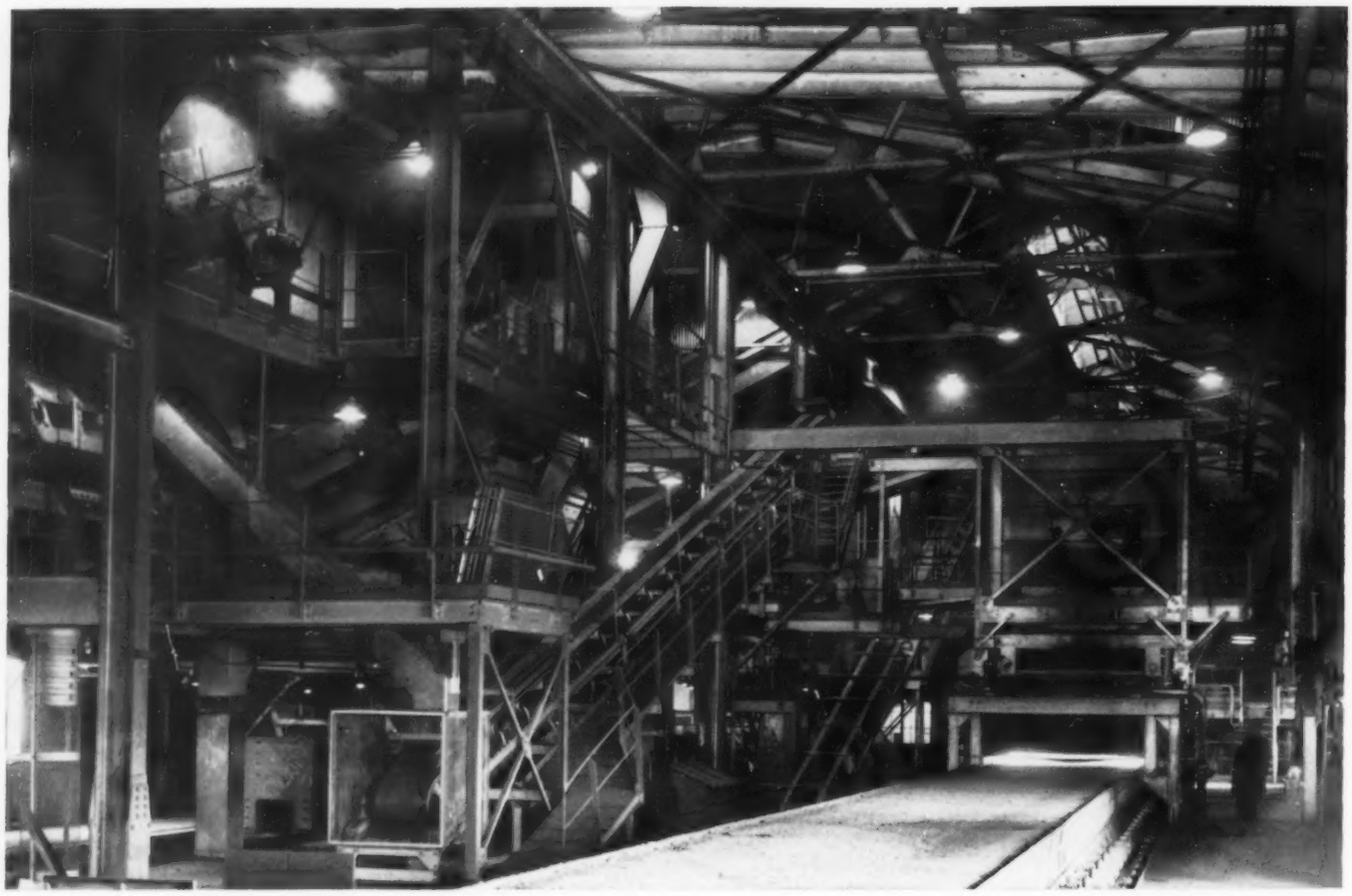
Δ Now that the Bethlehem-Youngstown Sheet and Tube merger seems to be off, Sharon Steel and Pittsburgh Steel seem to be stirring up one.

Δ Molybdenum, which melts at 4748 F, has been cast by Bureau of Mines scientists. A 30-lb charge was melted in a water-cooled copper-lined crucible, using a high-density electric arc in an inert atmosphere. The molten material was cast into a rotating graphite mold to form a hollow cylinder 8 in. long x 4½ in. in diameter. Officials term it "a major metallurgical break-through." Industry seems a bit more cautious.

Δ Robert M. Hutchins, president of Ford Fund for the Republic, says college degrees are becoming an increasingly important job requirement, while requirements for a degree have sunk lower and lower. He suggests a possible solution by awarding a degree to every person when he is born.

Δ People who cry loudest about how much more it costs to live now than it used to would complain hardest if they had to live as they used to.

Δ For whatever interest it may have, Revolutionary War pensions ended in 1911; War of 1812 pensions ended in 1946. Civil War pensions are still going, as well as those of subsequent conflicts. Incredible as it seems, pensions seem to linger on about 130 years after the war is over, and by that time there've been two or three more to pay on.



Sinter Plant Conveyor System at exciting new Jones & Laughlin Cleveland Works equipped with Dodge Products for dependability

The conveyor system of this modern sinter plant, engineered and erected by Arthur G. McKee & Company, is equipped with Dodge Taper-Lock Steel Conveyor Pulleys and Dodge Type C Pillow Blocks with Timken Tapered Roller Bearings.

Maximum strength with minimum weight is a feature of these conveyor pulleys. Steel rims, discs and hubs are fused together into jointless drum construction for terrific impact resistance. With the unsurpassed holding power of Taper-Lock mounting there is no "walking on the shaft."

Dodge Type C Pillow Blocks with Timken Tapered Roller Bearings were chosen for their extraordinary ruggedness. They have *high* radial and thrust capacities, they are fully self-aligning, triple sealed against the most severe conditions of dust and other contamination and they are adjusted, lubricated and sealed at the factory for a long life of dependable service.

DODGE MANUFACTURING CORPORATION, 5900 Union St., Mishawaka, Ind.

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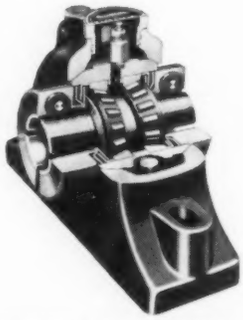
CALL THE TRANSMISSIONEER—your local Dodge Distributor. Factory trained by Dodge, he can give you valuable help on new, cost-saving methods. Look in the *white* pages of your telephone directory for "Dodge Transmissioneer."

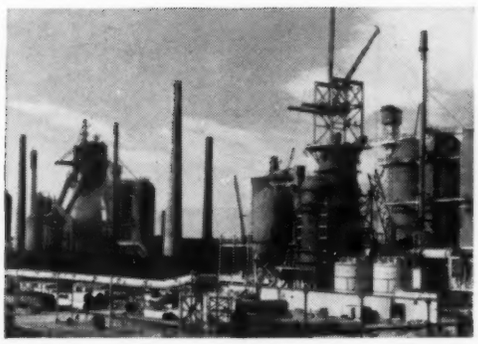
DODGE TAPER-LOCK STEEL CONVEYOR PULLEYS



DODGE TYPE C PILLOW BLOCKS WITH TIMKEN BEARINGS

I call KE for plant expansion or new facilities
N call KE for plant expansion or new facilities
G call KE for plant expansion or new facilities
E call KE for plant expansion or new facilities
N U I T Y

has made KE a major
engineer-contractor serving Steel



At India's mammoth Tata works, at Jones & Laughlin, at Kaiser Steel—Kaiser Engineers' ingenuity advances the art of making steel.

KE can take your development thoughts from a gleam in your eye through start-up. KE performs any part—economic analysis, plant location, engineering, design, procurement, expediting, construction. One contract can cover all.

For your next plant or expansion, take advantage of KE's cost-saving ingenuity and wide experience in Steel.

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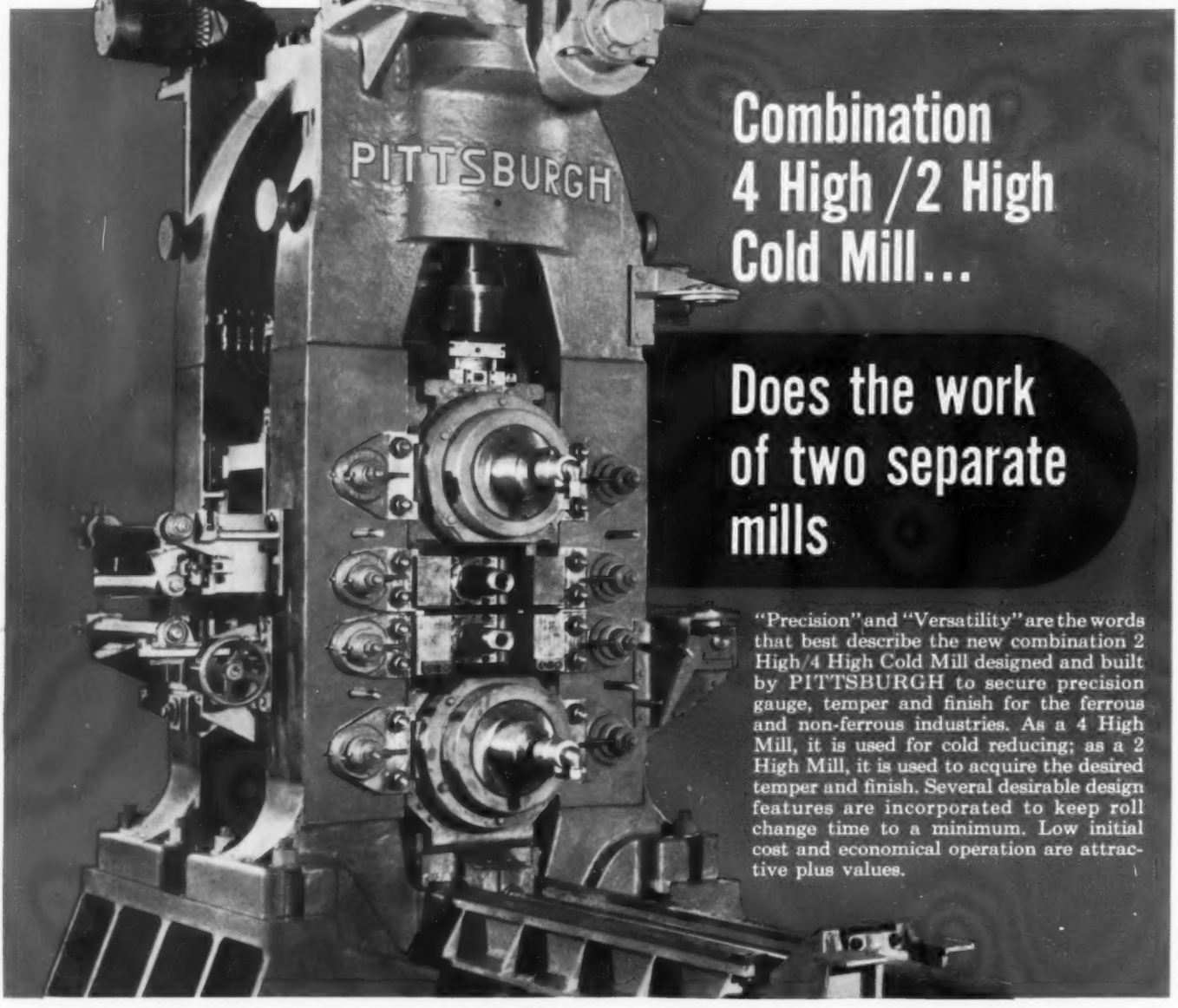

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Does the work of two separate mills

"Precision" and "Versatility" are the words that best describe the new combination 2 High/4 High Cold Mill designed and built by PITTSBURGH to secure precision gauge, temper and finish for the ferrous and non-ferrous industries. As a 4 High Mill, it is used for cold reducing; as a 2 High Mill, it is used to acquire the desired temper and finish. Several desirable design features are incorporated to keep roll change time to a minimum. Low initial cost and economical operation are attractive plus values.

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Our plant is equipped with a superior complement of well diversified machine tools that are available on a continuing basis for economical machining of heavy castings or the manufacture of auxiliary rolling mill equipment, such as heavy mill tables, furnace pushers, slab depilers, downcoilers, ingot buggies, slab transfers, etc.

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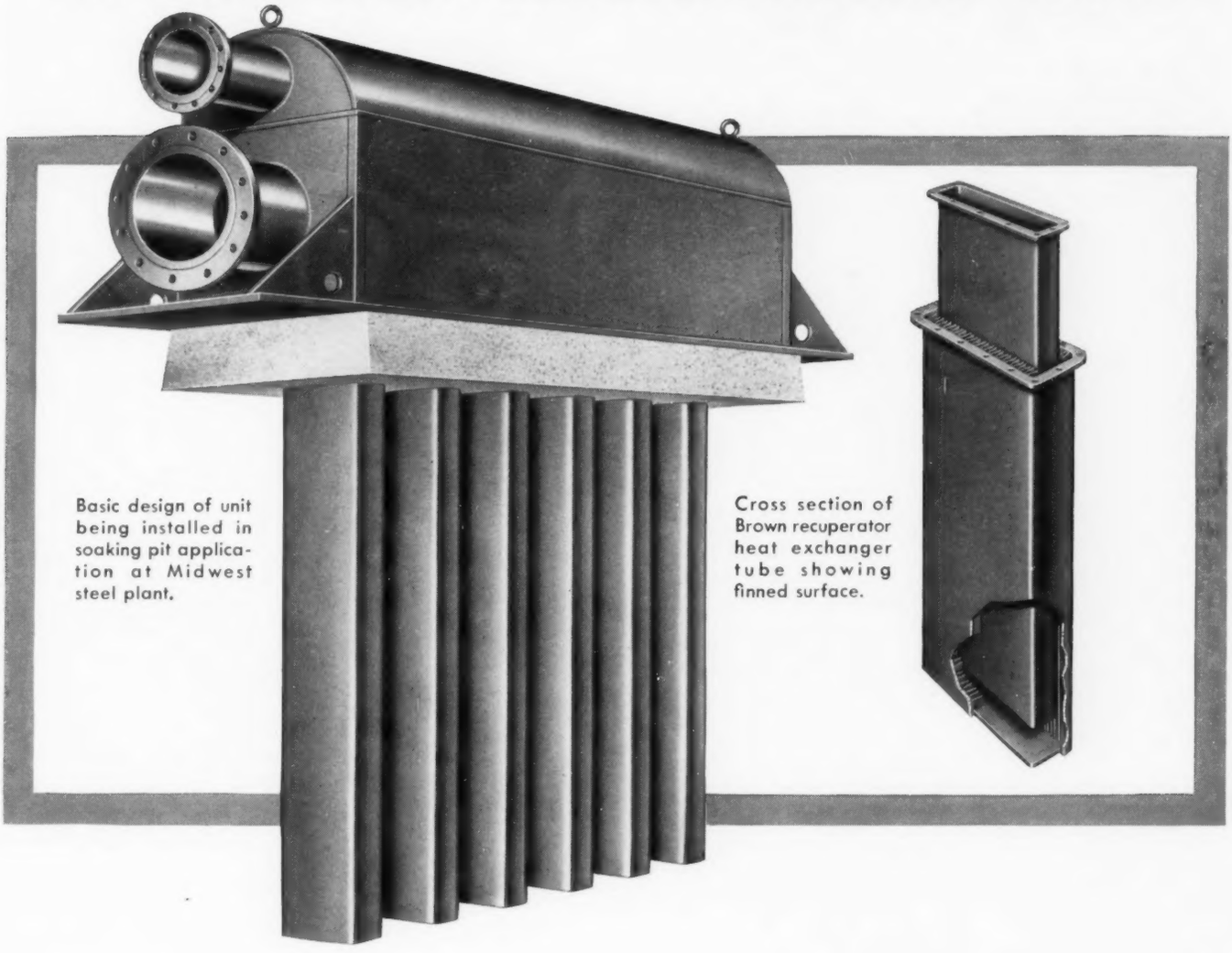
Increase heat transfer surface 314%



Basic design of unit being installed in soaking pit application at Midwest steel plant.

Cross section of Brown recuperator heat exchanger tube showing finned surface.

- Brown fintube extended surface (up to 314%), made possible by use of fins integrally welded to the tube, acts to cool the outside tube wall, thus resulting in a low wall (metal) temperature during operation, which insures long life.
- Less floor space required, due to increased heat transfer with extended finned surface area.
- By suspending recuperator tubes from the top only, the expansion of metals is provided for and costly expansion joints are eliminated.
- Recuperators can be serviced during operation minimizing furnace downtime.
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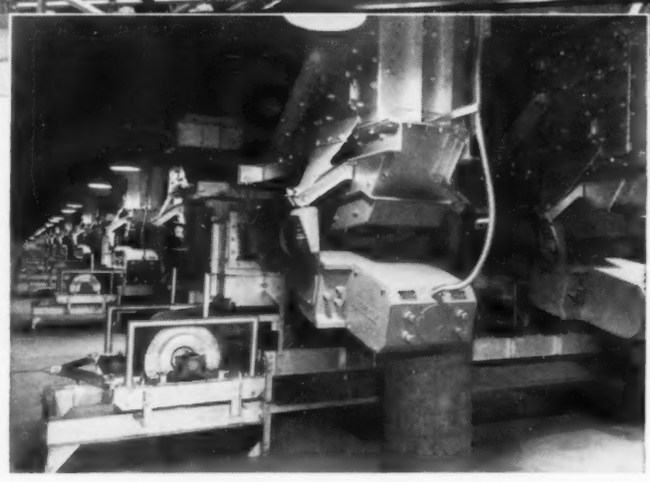
Jeffrey magnetic separators help raise iron content of pellets to 64%.

Jeffrey vibrating feeders keep ore on the move.



New Taconite Plant sets 24-hour, year-round pace!

IRON YIELD of the Mesabi Range is being greatly extended by a new plant which can, *every day*, turn about 63,000 long tons of taconite ore into approximately 20,000 tons of pellets bearing up to 64% iron. Efficient, trouble-free Jeffrey equipment is an important part of the vast and highly mechanized operation which makes this processing economically practical.

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Jeffrey Vibrating Feeders – 48 heavy duty 5DTS units feed coarse ore from surge bins to cone crushers and screens. 324 Type 4DTH units feed fine ore to rod mills. 48 Type 4DTS feeders handle hot pellets. Balanced vibration assures quiet operation, definite control, easier installation, low operating and maintenance costs.

In all types of mining and processing of solids, carefully engineered, precision built Jeffrey machinery and components provide long, dependable service. Write for Catalog 910. The Jeffrey Manufacturing Company, 840 North Fourth Street, Columbus 16, Ohio.

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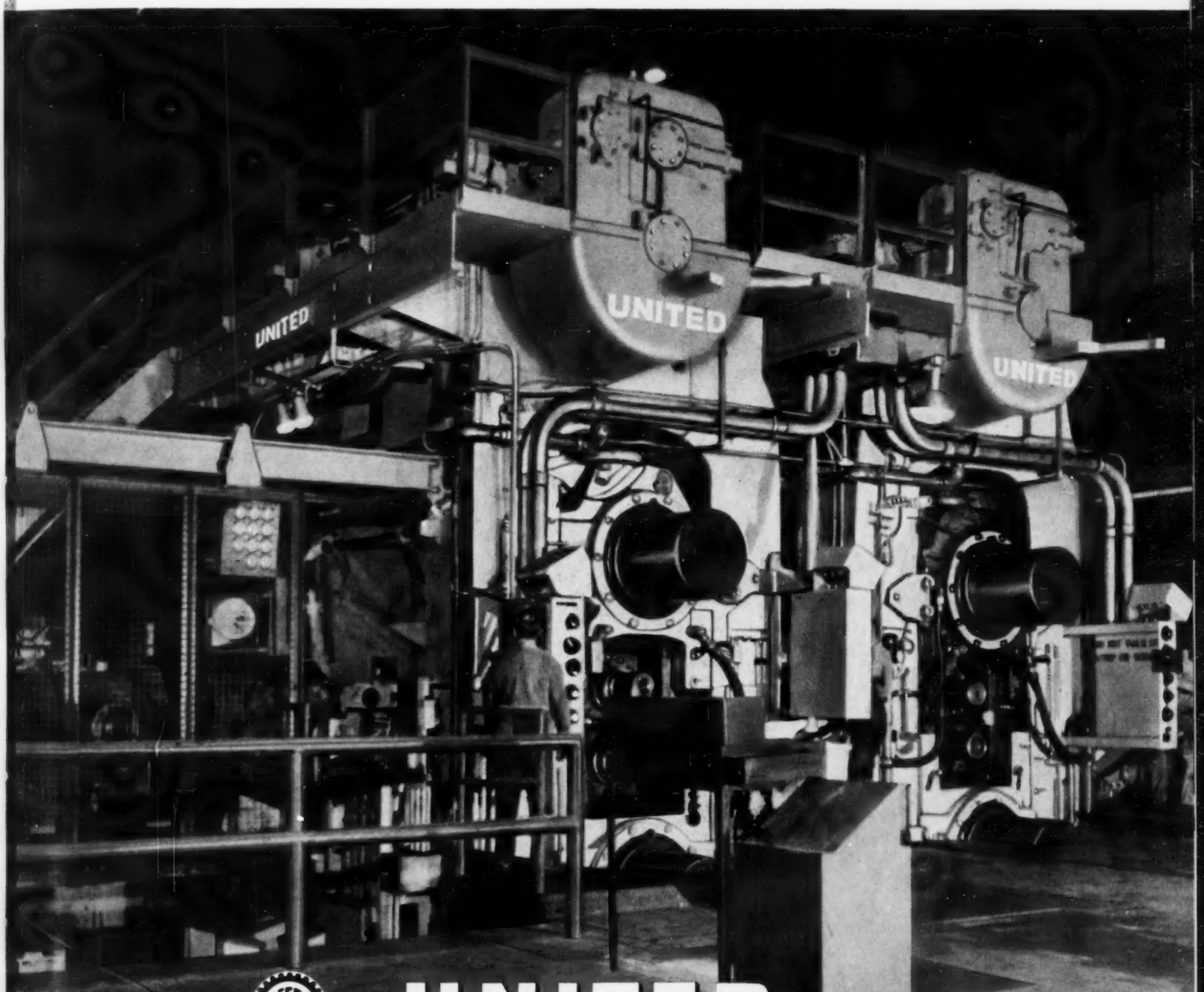

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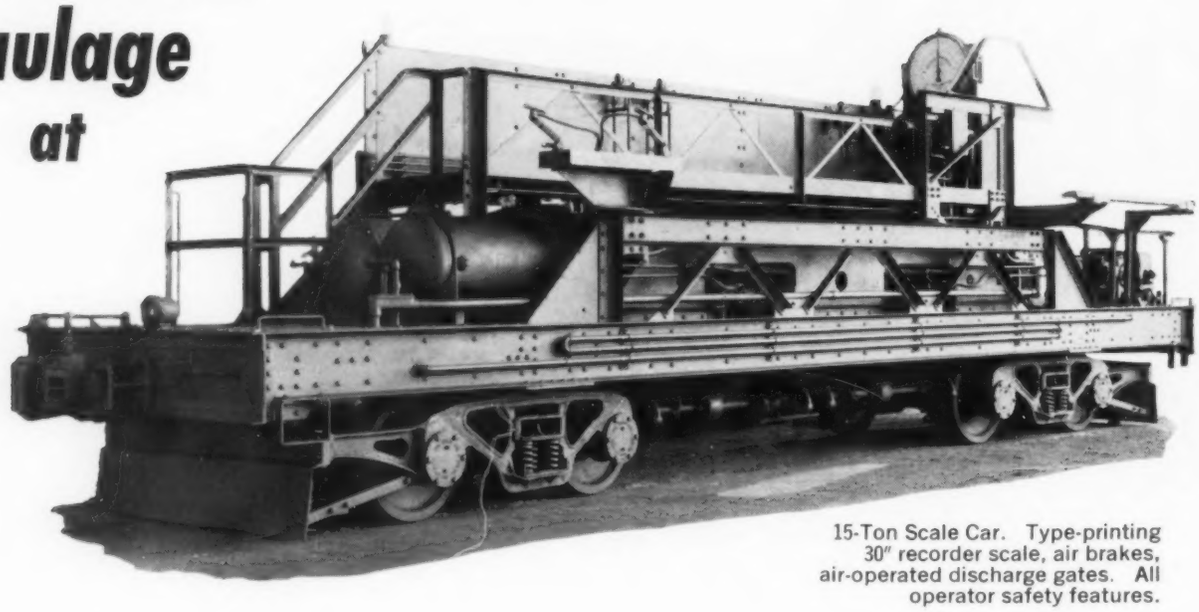

15-Ton Scale Car. Type-printing 30″ recorder scale, air brakes, air-operated discharge gates. All operator safety features.

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The special purpose cars shown here were designed and built to meet the exacting needs of steel plant service. Simplicity and ruggedness add to their dependability.

75-Ton Diesel-Electric Transfer, single hopper, bottom dump with air-operated discharge gates and double end control.

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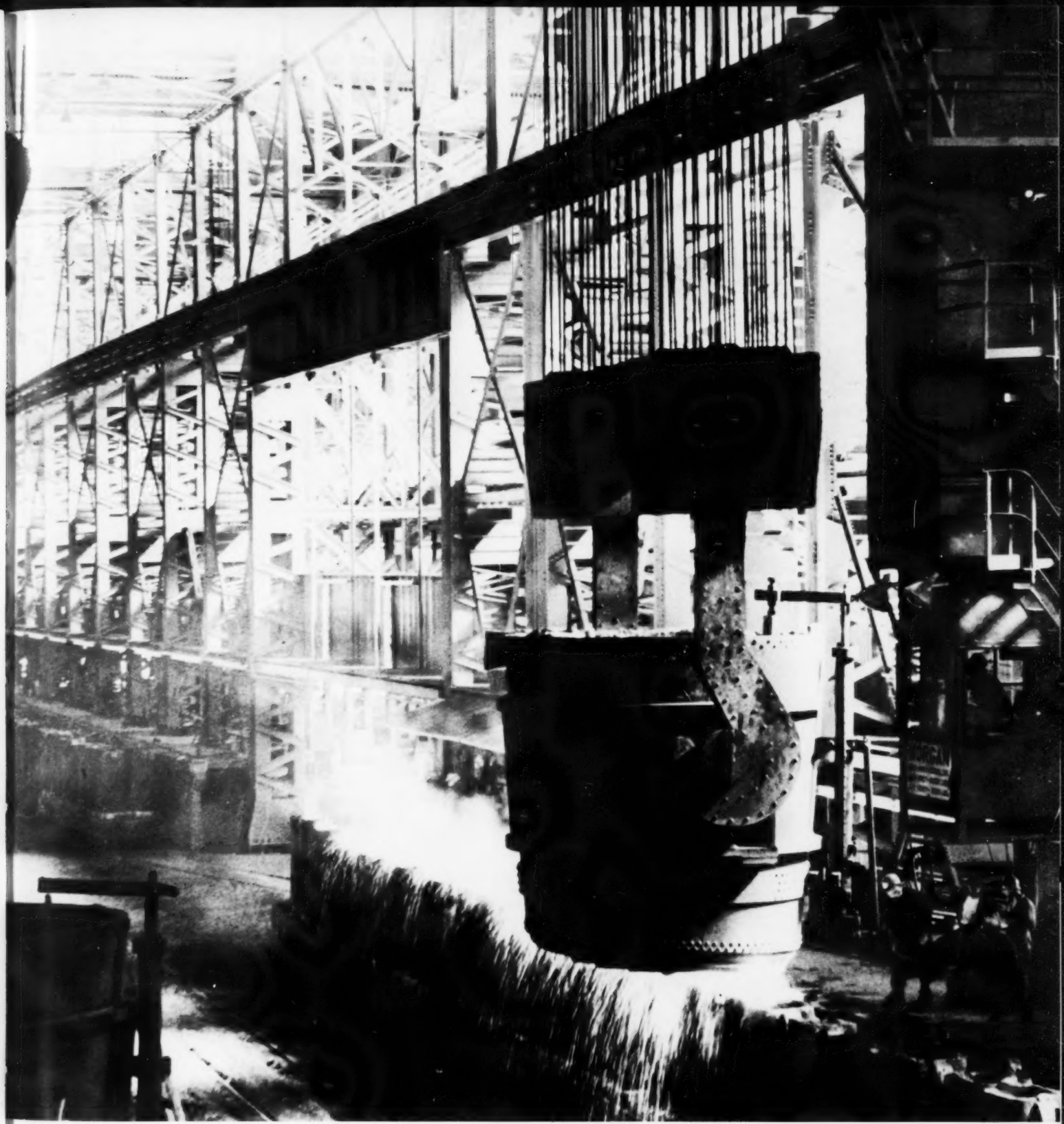
1140 IVANHOE ROAD **CLEVELAND 10, OHIO**



despite dirt... heat... brutal shock loads...

STEEL PRODUCTION KEEPS ROLLING

ECONOMICALLY ON **HYATT**

ROLLER BEARINGS

HYATT

the standard bearings

GREATER CAPACITY

It is an accepted fact that cylindrical bearings have greater radial load-carrying capacity, size for size, than any other kind of anti-friction bearing because of the larger area of contact between races and rollers.

SHOCK RESISTANCE

This greater contact area reduces elastic deflection under heavy loads. As a result, HYATT Hy-Roll cylindrical bearings are more tolerant of the shock loads in steel mill service.

HEAT RESISTANCE

Where heat causes temperature expansion, HYATT races can be displaced axially without restricting movement of bearing parts. Moreover, internal clearances are so closely controlled that HYATT bearings will not "freeze" from expansion or contraction.

EASIER ASSEMBLY

HYATT straight cylindrical construction provides the utmost in easy assembly and disassembly because holding devices, shim adjustments, etc. are unneeded in most applications.

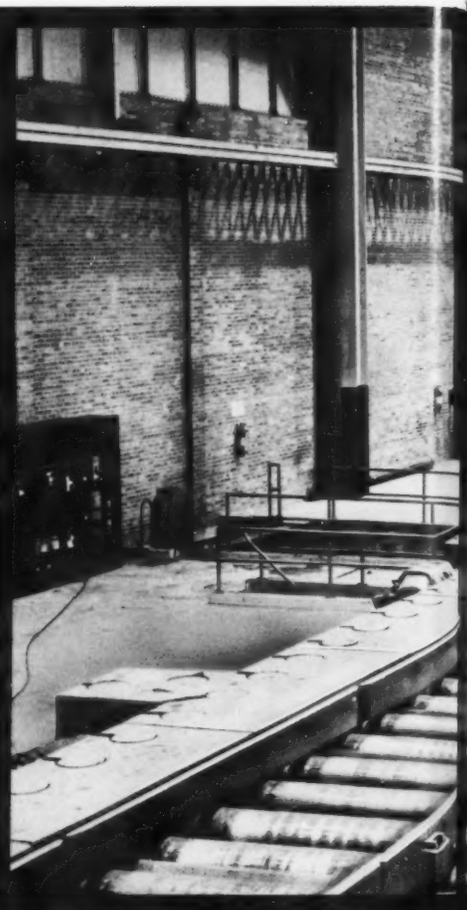
LESS MAINTENANCE

HYATT bearings require only a fraction of the attention and routine maintenance needed by other bearing types. HYATT'S advanced design, scientific material selection, modern manufacturing methods and rigid quality control help to substantially reduce maintenance costs and to assure

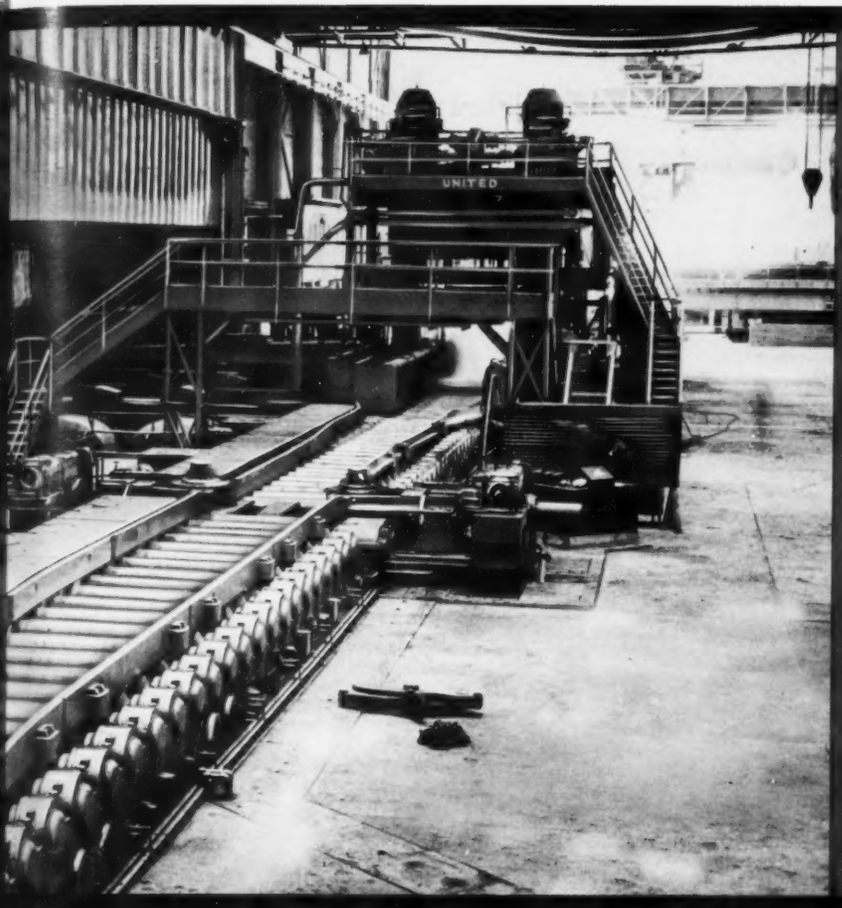
MORE and BETTER STEEL PRODUCTION

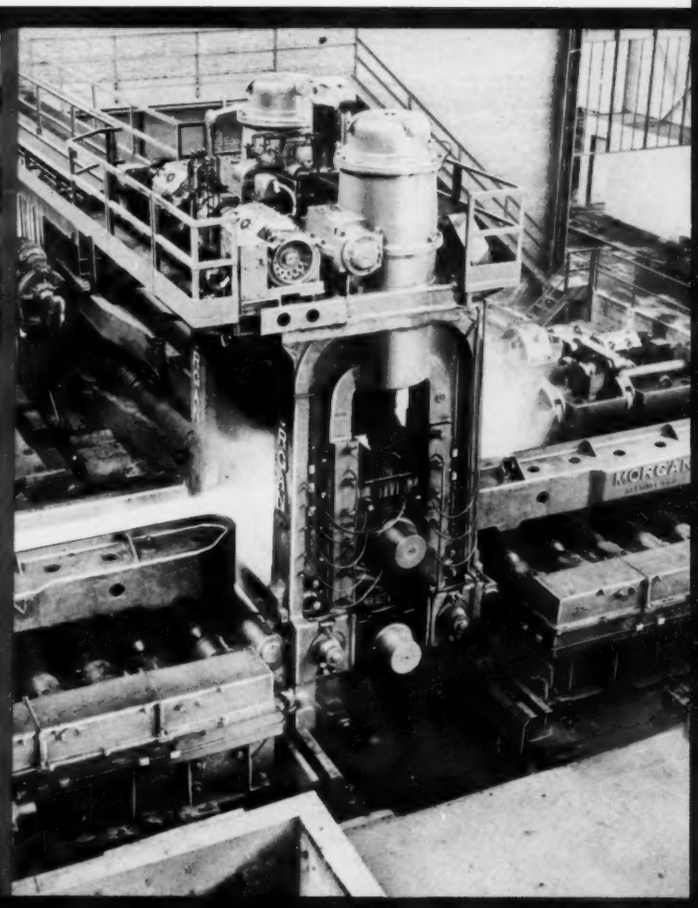
rolling mill tables

HYATT bearings are preferred by leading rolling mill builders for table, feed roller, line shaft and drive positions because they withstand shock loading, temperature changes, are so easy to install and remove, and require so little maintenance.



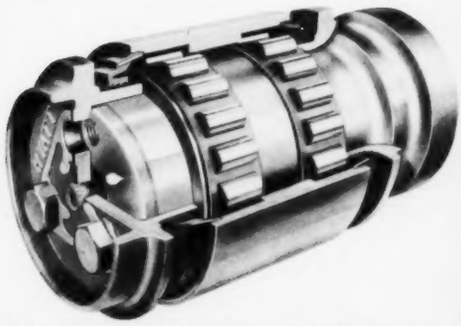
of the steel industry





mill and industrial cars

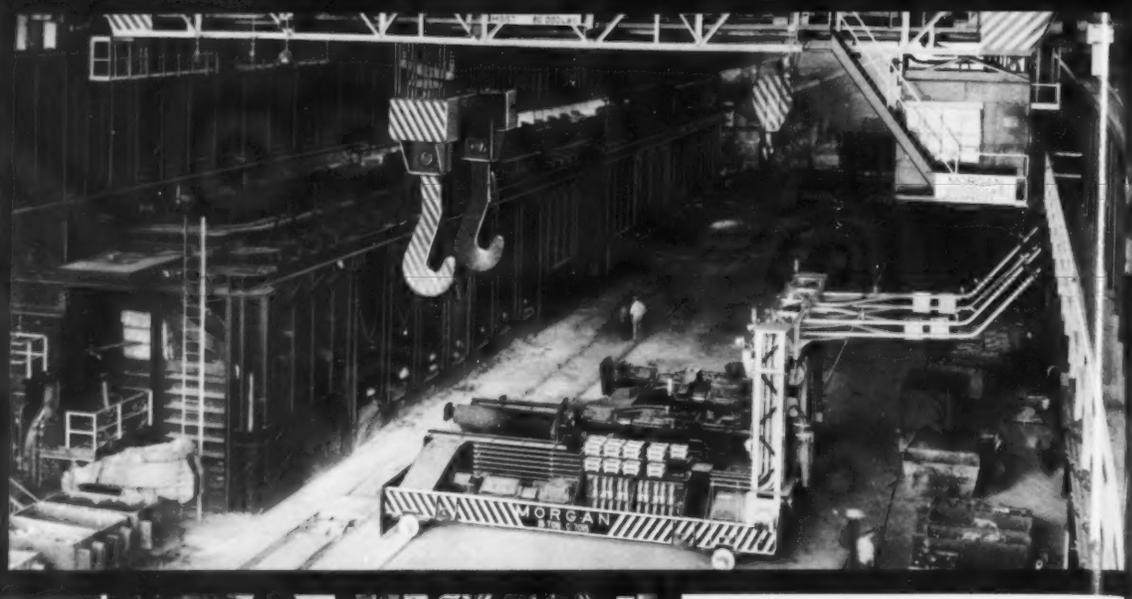
Severe shock loads make rugged bearings a "must" on transfer, charging box, ingot mold and similar heavy-duty mill cars.

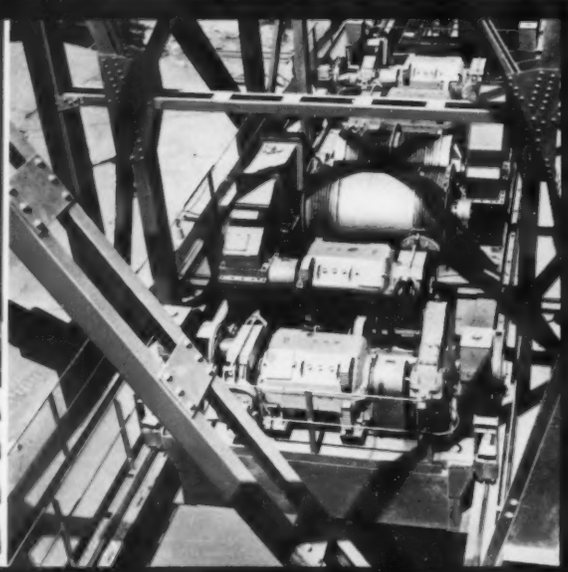


THE HYATT HY-ROLL BEARING, originally developed for railroad freight service, is proving highly successful and economical on mill cars.

material handling equipment

The extra radial load-carrying capacity of HYATT bearings assures superior performance in heavy-duty continuous service on track wheels, sheaves and drives of cranes, charging machines, strippers, etc.



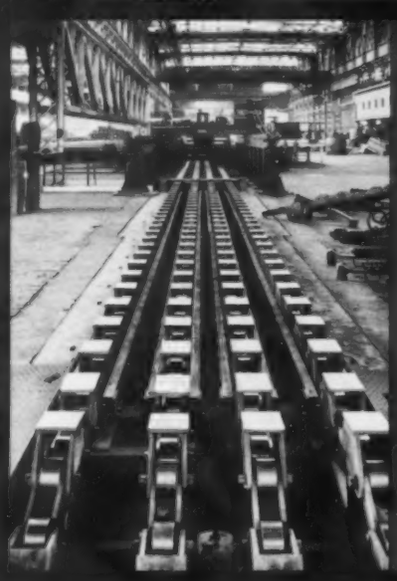


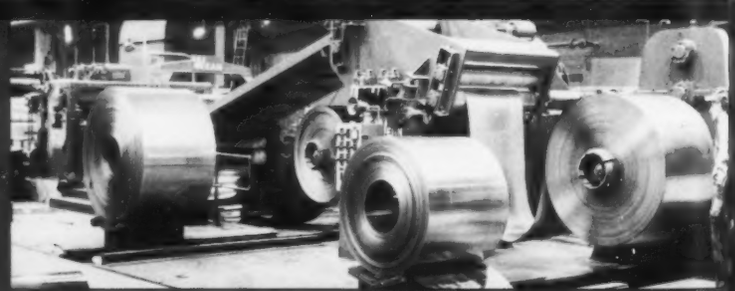
steel mill motors

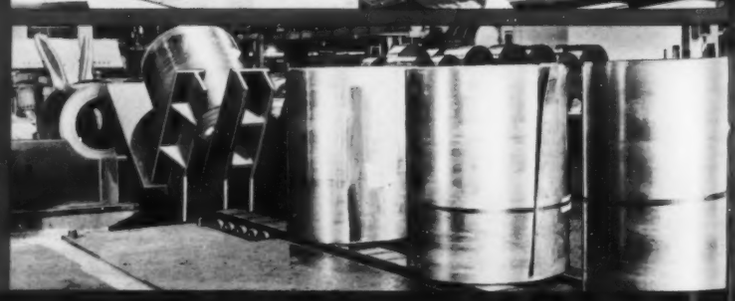
Heavy loads, overhung pinions, high torque, instant reversal, high heat and continuous operation make dependable HYATT bearings the overwhelming choice for heavy-duty mill motors on run out tables, ore bridges, screw downs and cranes.

auxiliary equipment

HYATT bearings have been performing dependably in almost every kind of equipment used to make, form and finish steel since HYATT pioneered in helping the steel industry convert to anti-friction bearings more than a third of a century ago.







No bearings carry radial loads like cylindrical bearings—and *nobody* knows them like HYATT!

THE RECOGNIZED LEADER IN CYLINDRICAL BEARINGS

GM GENERAL MOTORS

HYATT HY-ROLL BEARINGS FOR STEEL INDUSTRY

HYATT BEARINGS DIVISION • GENERAL MOTORS CORPORATION • HARRISON, NEW JERSEY

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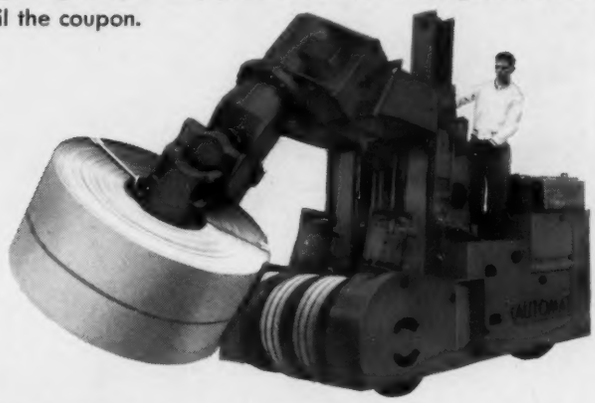
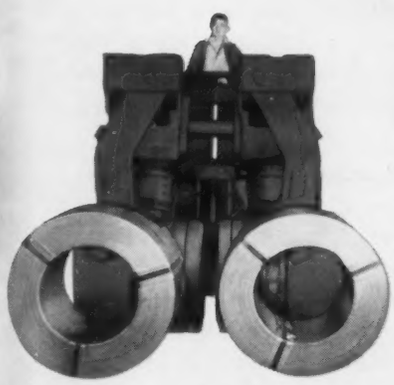
Most Complete Line of Steel and Die Handling Equipment
Capacities up to 110,000 lbs. or more

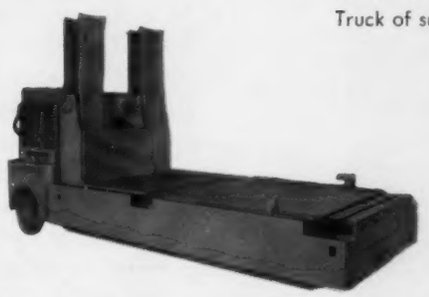
In the heavyweight division of materials handling, no other line matches the versatility and range of Automatic's heavy duty trucks. This is the direct result of many years of specialized engineering and manufacturing experience in the coil and die handling field. The five examples shown here comprise only a small sampling of the wide range of heavy duty handling requirements served by Automatic equipment. So don't hesitate to call us in on any problem involving weights up to any practical limit. No obligation, of course. Just mail the coupon.



COIL-UPENDER ATTACHMENT: Picks up coil in vertical position and rotates to horizontal or vice versa. Holds coil securely throughout rotation... prevents telescoping. Handles up to 60,000 lbs. Now available on Automatic HR Series or as an attachment for any Automatic Truck of suitable design and capacity.



SKYLIFT GIANT: Heavy duty mast type truck available with either forks or ram. Model shown here has split ram to handle either 1 or 2 coils at a time. CAPACITIES: 20,000 through 80,000 pounds or more.



SERIES TLO: First heavy duty die handlers ever made with completely hydraulic loading, unloading and lift. Bullards move much faster and smoother than in any mechanical system... unloads at end or either side to meet any requirements of space and accessibility. CAPACITIES: 4,000 to 110,000 pounds or more.

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lets you improve the operation of your blast furnaces

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Specifications and technical data are available. Contact your local Electro-Alloys representative, or write Electro-Alloys Division, American Brake Shoe Company, 1042 Taylor Street, Elyria, Ohio.

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patent reviews

By MELVIN NORD, Patent Attorney, Detroit, Mich.

Copies of patents may be obtained from the Commissioner of Patents, Washington 25, D. C., at 25 cents . . . . patents reviewed cover period September 2, 1958 through September 30, 1958

TWO-STEP REFINING PROCESS IN A TILTABLE ROTARY FURNACE

△ U. S. 2,853,377, issued Sept. 23, 1958 to Bo M. S. Kalling and Folke C. E. Johansson, assigned to Stora Kopparbergs Aktiebolag, relates to the refining of molten pig iron by oxygen in a tiltable rotary furnace.

If the process is carried out in a rotary furnace, a vivid bath movement can be obtained during the entire process. Hereby the reactions between the metal bath and the slag bath take place more rapidly and more completely. This makes it possible to reduce the iron percentage in the final slag and thereby in an essential degree to increase the metallic iron yield. By the rotation it is, furthermore, possible to obtain a sufficient contact between the oxygen and the bath without having to blow the oxygen onto or into the bath at a high super pressure, which is necessary with a stationary furnace. The oxygen tuyere need not be directed against the bath. In this manner the oxygen gas will to a certain extent be mixed with the furnace gases before it reaches the bath and the contact with the latter will be spread over a relatively great surface. Thus the gasification of iron and manganese is reduced, which gasification arises at the strongly localized supply of oxygen which is unavoidable in stationary furnaces and causes great losses of iron by the escaping gases, whereby an extremely annoying smoke is formed.

After the furnace has been charged with 30 tons of molten pig iron containing 0.5 per cent Si, 2.0 per cent P and 1.0 per cent Mn, and 3000 kg of lime and 2500 kg of ore have been added as cooling medium, oxygen gas is blown into the furnace for approximately 15 min with the latter in an approximately horizontal position with the furnace axis at about 20 degrees to the horizontal and with a relatively high speed of rotation of about 30 rpm in order that the strong smoke formation at the oxidation of silicon, phosphorus, and manganese shall be counteracted. After said blowing period when the boiling sets in seriously and gives rise to a sufficient stirring, the rotation is interrupted and the furnace is raised to a substantially vertical position. A slag is tapped, and a further quantity of 1000 kg of limestone and 1500 kg of ore are charged to the bath in the furnace. The blowing is then continued by blowing oxygen, through a vertical oxygen tuyere, against the bath under conditions to displace slag and bring the oxygen stream into direct contact with the surface of the underlying metal. The furnace is not rotated during this phase which lasts about 10 min and brings the carbon percentage down below 0.3 per cent. At the final phases of the process, which takes about three minutes, the blowing is again carried out with the furnace rotating in a horizontal position in order that the speed of reaction between the slag and the steel bath shall be increased and thereby the iron losses in the slag be reduced. After this phase the steel is tapped in a ladle as in conventional practice.

OXYGEN BLOWING PROCESS

△ U. S. 2,851,351, issued Sept. 9, 1958 to Otwin Cuscoleca, Felix Grohs, and Wolfgang Kuhnelt, assigned to Oesterreichisch-Alpine Montangesellschaft, describes a process for refining pig iron to steel by blowing oxygen onto the bath surface from above. The object is to avoid over-oxidation of the bath, which is caused by excessive penetration of the jet into the bath.

The invention essentially resides in piercing the slag layer with the aid of a solid body adjacent to the impact area of the blast jet at the beginning of the blowing operation. By the mechanical piercing of the slag layer at least for an instant, the contact between the blast and the metal bath is established; this is sufficient to initiate the process, whereafter the continuation of the process is promoted by the ebullition of the bath.

In Figure 1, I designates the converter, 2 the metal bath, and 3 the slag layer. The nozzle is designated as 4, the nozzle holder as 5. The nozzle holder has fixed to it by means of a readily fusing wire 7, an

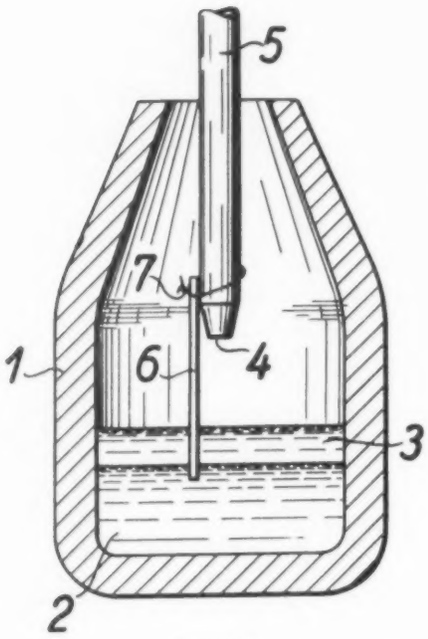


Figure 1

iron rod 6, which extends through the slag layer 3 into the metal bath 2. After a few seconds the wire 7 is fused, but the rod 6 has already pierced the slag layer 3 as the nozzle holder 5 was moved into the converter. Thus the reaction has been initiated. When the rod 6 drops into the bath the slag layer is pierced vigorously once more.

SINTERING MACHINE

△ U. S. 2,853,288, issued Sept. 23, 1958 to Edwin B. Hudson, assigned to Armco Steel Corp., describes a sintering machine such as is used in the sintering of ore and flue dust.

Conventionally, such machines have a so-called head sprocket and a so-called tail sprocket. Upper and lower rails are provided and the head sprocket is driven. Generally the head sprocket has means for engaging pallets which carry the ore or flue dust to be sintered, and the drive from the sprocket to a particular pallet is transmitted to all the other pallets ahead of it on the sintering path. Thus, the pallets are slowly moved along a path during which they are subjected to the sintering treatment.

At the tail end of the machine, curve guide rails are associated with the tail sprocket and the pallets pass down around the tail sprocket and return to the head sprocket along a lower path empty and ready for recharging when they are picked up by the head sprocket.

An objection to machines of this type is that they use a large number of pallets which pallets, during approximately half of their travel, are not in use. They return to the charging point at a very slow speed and, therefore, they have cooled down considerably by the time they are recharged. The additional pallets are expensive and it is desirable to eliminate as many pallets as possible if this can be done without reducing the production capacity of the machine.

The present invention overcomes these difficulties, by providing means to drive the pallets on their return path at a very much greater speed than they are driven on the sintering path.

In Figure 2 the pallets are indicated at 10 as they move along the sintering path. A series of pallets are indicated at 11 which are being elevated by the head sprocket to charging position. A pallet is indicated at 12, which is being lowered to the return path and a pallet is indicated at 13 moving along the return path. The head sprocket is shown at 14 and it is driven through a gear train, as shown by a motor 15. Material to be sintered is delivered to the pallets 10 by a feeder 16 and the pallets then pass under the hood 17 which carries off the hot air passing upwardly through the pallets from the wind box 18. The pallets then pass the furnace 19 where the charge is predried and ignited and the pallets then continue to pass over the wind boxes 20.

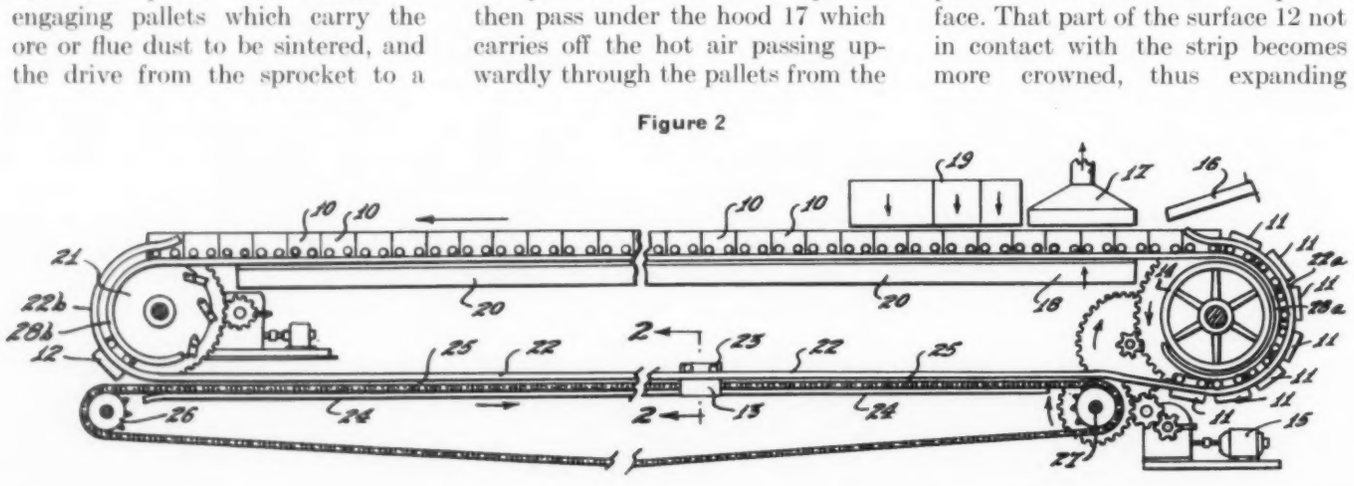
The pallets are returned to the head end of the machine as indicated at 13. The pallets 13 are in upside-down condition and hang from rails 22 by means of their wheels 23. Beams 24 carry the chains 25 which engage the pallets and pull them along the rails 22. The chains 25 run over sprockets 26 and 27 and the sprocket 27 may be driven through other gearing from the same motor 15, so as to move at a much faster linear speed.

FLEXIBLE SELF-CENTERING ROLL

△ U. S. 2,854,235, issued Sept. 30, 1958 to William H. Mursch and assigned to United States Steel Corp., describes an automatic self-centering roll for centering and alining strip or a belt under relatively low tensions and low speeds where it is desired to have a rubber surface in contact with the strip passing over it.

In Figures 3 and 4, reference numeral 2 indicates bearings, for supporting the self-centering roll 4. The roll 4 consists of a shaft 6, a pair of webs 8 mounted on the shaft 6 and a hollow rotatable rim 10 extending between and supported by the webs 8. The webs 8 may either rotate with the shaft 6 or rotate on bearings supported on the shaft 6. The rim 10 is made of rubber. The rubber rim 10 is cemented to the webs 8. The outer surface 12 of the rim portion 10 is crowned. When a strip S passes over the roll 4 under tension, the surface 12 in contact with the strip pulls down flat with the strip surface. That part of the surface 12 not in contact with the strip becomes more crowned, thus expanding

Figure 2



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It will pay you to investigate the many advantages JCS Control Houses and Pulpits offer.

Write now for our free descriptive brochures. No obligation, of course.

Pictured above are JCS Control Houses installed at the Cleveland Works Div. of Jones & Laughlin Steel Corporation. Here two operators in one Pulpit easily, efficiently operate four hot mills.

SPECIAL FEATURES AVAILABLE IN JCS CONTROL HOUSES AND PULPITS

4" Insulated Walls

Double or Triple lights of heat treated windows

Acoustic steel tile ceilings

Tile Floors

6 way adjustable operator's padded chairs

Concealed conduit in walls and floor

Indirect lighting

Raceways steel desks and panel boards

Air Conditioning and heating

Rugged construction yet modern, attractive design . . . and lavatories, water closets, showers, lockers, benches, cabinets—whatever suits your needs best:

Originators and Developers of the Modern Mill Pulpit

James Campbell Smith, Inc.

4057 Erie Street, Willoughby, Ohio

Figure 3

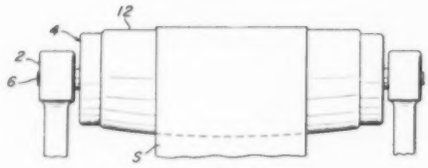


Figure 4

the surface. As the roll rotates each increment of this expanded surface moves in toward the transverse center of the roll and as the strip comes in contact with it this movement continues until it reaches a maximum. This movement with the strip in contact with it tends to move the strip to the centerline of the roll.

PACK ANNEALING

△ U. S. 2,850,928, issued Sept. 9, 1958 to Edward T. Peterson and Edward C. Peterson, relates to pack annealing mechanism for use in connection with rolling mills for steel products.

Batch pack annealing has mainly been accomplished in the straightening notch or in inclined surfaces below the straightening notch, permitting only limited length of the pack. With continuous packing when the forwardmost bar has been released, it has been tilted forward, so that as a consequence the rearward bars are lying on top of the more forward bars as the bars enter the cooling bed beyond the pack. It has been customary to operate the pack annealing by mechanism which is located below the pack.

These practices have led to a number of difficulties which the present invention is designed to overcome.

The present invention is designed to provide longer packs by erecting the pack on cooling bed bars rather than in the straightening notch or a special notch, thus permitting packs limited only by the width of the bed, and the construction of the packing mechanism.

Furthermore in accordance with the prior art practice of allowing the forwardmost bar to tilt forward and fall forward after leaving the pack, subsequent bars overlying the initial bar have tended to interfere with separation of the bars at the runout table. With continuous packing there has been a tendency for bars to become confused and mixed up, and in some cases the very hazardous process of sending men on the cooling bed to straighten out the bars has been adopted.

By the present invention, each bar is tilted so that it will fall backward when the pack is released and thus the more forward bar is on top and less likely to become mixed in position.

COOLING WATER SPRAY HEAD AND COLLECTOR TROUGH FOR MILL ROLLS

△ U. S. 2,849,905, issued Sept. 2, 1958 to Carl Heinz and assigned to United States Steel Corp., provides apparatus for fluid-cooling the work rolls of metal rolling mills.

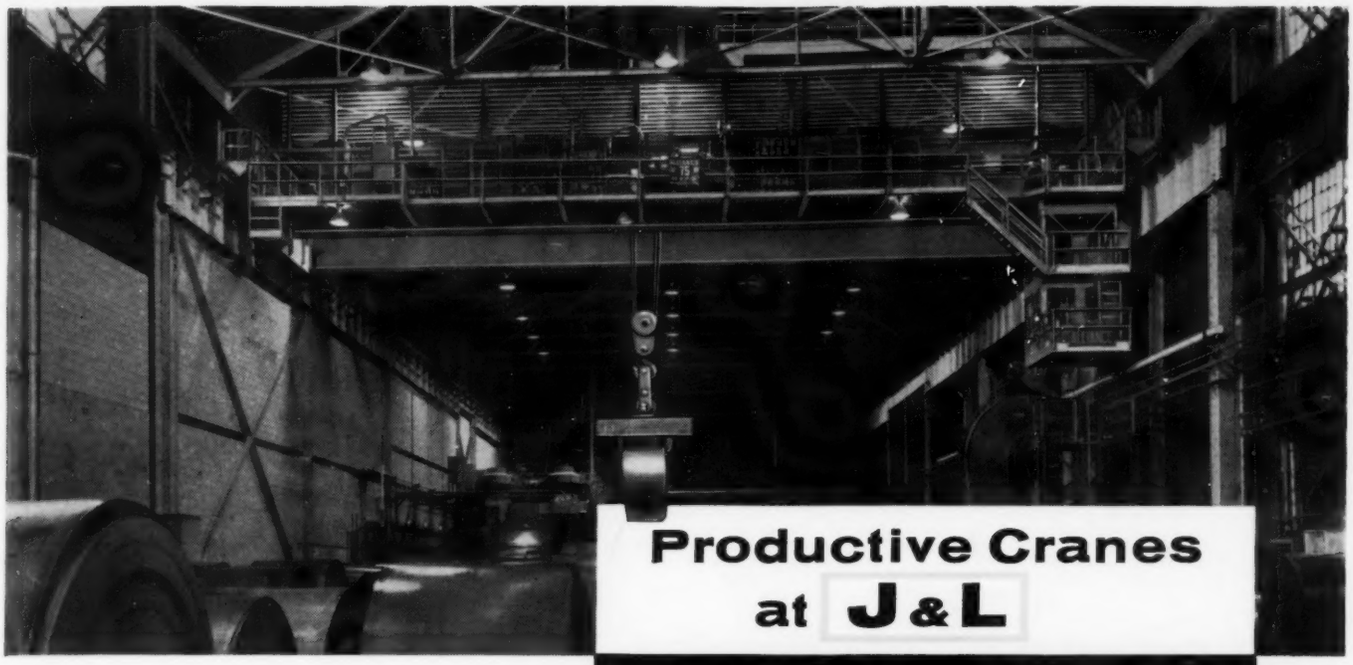
In Figure 5, reference numeral 2 designates generally a metal rolling mill provided with an upper work roll 4 and lower work roll 6 mounted in the housing 8 defining a roll pass for rolling a metal strip S.

A spray assembly, having header pipes 26 and nozzles 28, is mounted on the leg 18 with the nozzles 28 directed toward the upper work roll 4. Water is supplied to the header 26 by means of a flexible rubber hose.

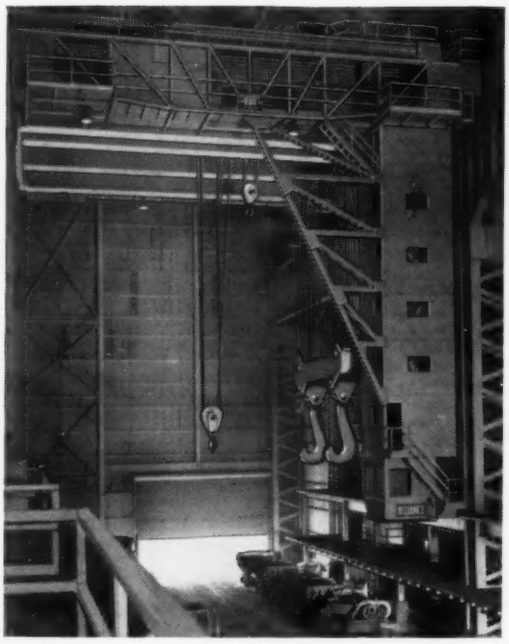
A wiper bar 34 made of wood is securely mounted on the leg 16 of the frame 12 by means of bolts 36, and bears against the periphery of

OTHER PATENTS OF INTEREST TO THE IRON AND STEEL ENGINEER

Patent No.	Date	Subject	Inventor or assignee
2,849,878	9/2/58	Apparatus for testing pipe couplings	United States Steel Corp.
2,850,092	9/2/58	Flying shear	United States Steel Corp.
2,850,173	9/2/58	Coke oven door lifter machinery	Sadao Shimazaki
2,850,374	9/2/58	Operation of a cupola	Jean-Baptiste Guillamon
2,850,380	9/2/58	Stainless steel	Armco Steel Corp.
2,850,448	9/2/58	Apparatus for electrolytically pointing wire	United States Steel Corp.
2,851,177	9/9/58	Coil receiving apparatus	United States Steel Corp.
2,851,347	9/9/58	Manufacture of iron powder	Badische Anilin- & Soda-Fabrik A.G.
2,851,384	9/9/58	Process of diminishing of ridging in 17-chrome stainless steel	Armco Steel Corp.
2,851,387	9/9/58	Method of degasifying high chromium steels prior to nitriding	The Chapman Valve Mfg. Co.
2,851,760	9/16/58	Patching of by-product coke oven tubular surfaces	Alan Wood Steel Co.
2,852,065	9/16/58	Roller leveller	Birdsboro Steel Foundry and Machine Co.
2,852,224	9/16/58	Quenching of coke	Koppers Co., Inc.
2,852,344	9/16/58	Production of ammonia from blast furnace gas	Rheinpreussen A.G. fur Bergbau und Chemie
2,852,422	9/16/58	Heat treating of steel	Selas Corp. of America
2,852,585	9/16/58	Arc melting furnace	Aktiengesellschaft fur Untermehnmunger der Eisen- und Stahlindustrie
2,852,586	9/16/58	Magnetic stirring apparatus	The British Thomson-Houston Co. Ltd.
2,853,245	9/23/58	Mill roll scraper	Abner Jacobson
2,853,289	9/23/58	Sintering machine	Koppers Co., Inc.
2,853,290	9/23/58	Apparatus for plugging a furnace tapping hole	Salem-Brosius, Inc.
2,853,376	9/23/58	Treating liquid cast iron to avoid formation of white cast iron	Centre Technique des Industries de la Fonderie
2,853,379	9/23/58	High strength alloy steel for structural and pressure vessels	Lukens Steel Co.
2,853,381	9/23/58	Steel responsive to austempering	Allegheny Ludlum Steel Corp.
2,853,410	9/23/58	Martensitic steel for high temperature application	Allegheny Ludlum Steel Corp.
2,853,440	9/23/58	Floor for broad coke ovens	Hughes By-Product Coke Oven Corp.
2,853,767	9/30/58	Production of high density ferrous alloy powder compacts	P. R. Mallory & Co., Inc.
2,853,768	9/30/58	Overhead conductor	United States Steel Corp.
2,853,905	9/30/58	Rolling mill pressure block support	United Engineering & Foundry Co.
2,854,196	9/30/58	Three-roll mill	Vickers-Armstrongs (Engineers) Ltd.
2,854,226	9/30/58	Annealing cover furnace	Surface Combustion Corp.
2,854,330	9/30/58	Stainless steel	Armco Steel Corp.
2,854,331	9/30/58	Ferrous alloy of high hardness and stress-rupture properties	Latrobe Steel Co.

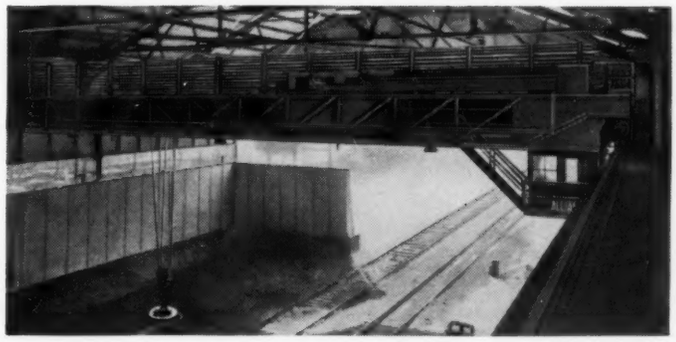


Productive Cranes at J&L perform at top efficiency under EC&M Control



ABOVE • Equipped with EC&M Control, this 200-ton ladle crane will spot heavy loads with "pin-point" accuracy

Production cranes, vital to maintained output, receive a big lift when EC&M controlled. Inherent in EC&M Control are the advantages of fast brake release for "pin-point" spotting, quick response to master switch manipulation and maximum safety at all times. Fast-operating LINE-ARC Contactors and Time-Current Acceleration Relays permit cranes to be operated smoothly under any load condition. The well-known EC&M Wright Dynamic Lowering Circuit is 100% safe. When buying cranes, it pays to specify EC&M Control.



RIGHT • Stockyard crane, servicing the slab conditioning area, is EC&M controlled

For complete facts on EC&M DC Crane Control, write for Bulletin 6100

THE ELECTRIC CONTROLLER & MFG. CO.
A DIVISION OF THE SQUARE D COMPANY
CLEVELAND 28 • OHIO

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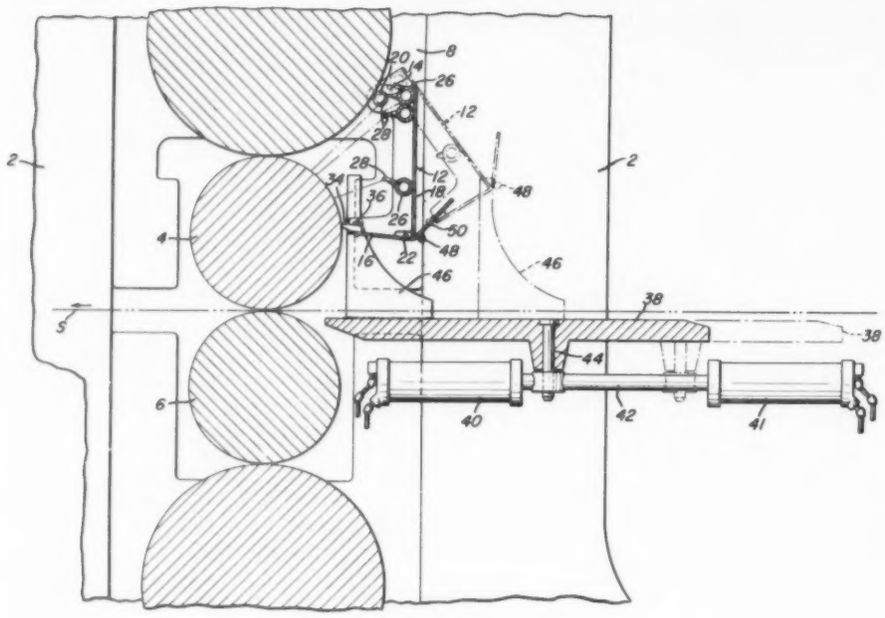


Figure 5

the work roll 4 parallel to its longitudinal axis in normal operating position. The wiper 34 has the dual function of diverting the flow of water from the roll surface and removing any scale particles which may adhere to the roll surface. The cooling water diverted by the wiper bar 34 is collected in a trough and discharged from both ends of the frame to a pit located below the mill without coming in contact with the strip S being rolled.

A reciprocating apron plate 38 is mounted on the mill below the pass line for movement toward and away from the mill. The apron plate 38 is reciprocated by means of a pair of pressure cylinders 40 and 41 provided with a common piston rod 42 which is connected with the apron plate by means of a pin 44.

A finger 46 is mounted on and projects upwardly from the apron plate 38 at the end toward the mill.

In operation, when it is necessary to change rolls in the mill, the cylinder 40 is actuated so as to cause movement of the piston rod 42 and connected apron plate 38 away from the mill. As the apron plate 38 moves away from the mill, the upwardly projecting guide finger 46 engages the pin 48 and swings the frame 12 upwardly away from the mill about its pivots 20 to the broken line position shown. The frame 12 is maintained in this position until the roll change is completed. After the roll change has been made, the cylinder 41 is actuated to move the apron plate 38 back to its solid line position with the frame 12 swinging back toward the mill by its own weight as the guide finger advances toward the mill.

ROLLING MILLS

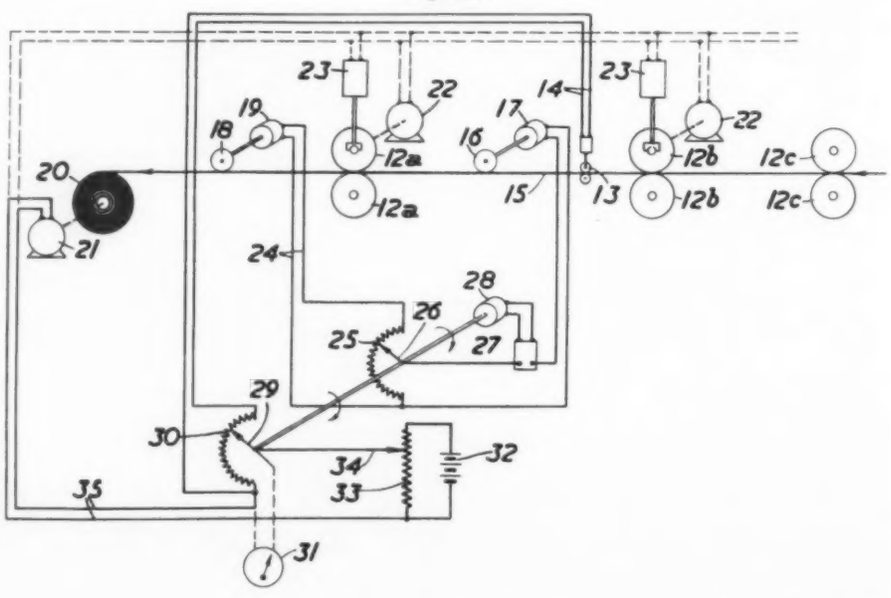
△ U. S. 2,851,911, issued Sept. 16, 1958 to Wilfred C. F. Hessenberg, assigned to the British Iron & Steel Research Association, relates to rolling mills for steel. It provides apparatus for measuring the issuing thickness of strip from a rolling mill and for controlling the mill to maintain a strip thickness at a desired value.

In the case of a wide strip mill where the width of the strip is not affected by rolling, the thickness of the strip multiplied by the speed of the strip will yield the same product at any point. This product is the output of the mill. The present invention employs the above features to provide apparatus for measuring the issuing thickness of strip from a rolling mill and for controlling the mill to maintain a strip thickness at a desired value. Thus, in a method of measuring the thickness of strip leaving a rolling mill, the outgoing thickness is derived from measurement of the speed and thickness of the strip prior to passage out of the mill and of the speed of the strip leaving the mill. For a multi-stand mill, the speed and thickness is measured between any two adjacent stands so that the output can be derived; the output is then compounded with the speed of the strip leaving the mill to give an indication of the issuing strip thickness.

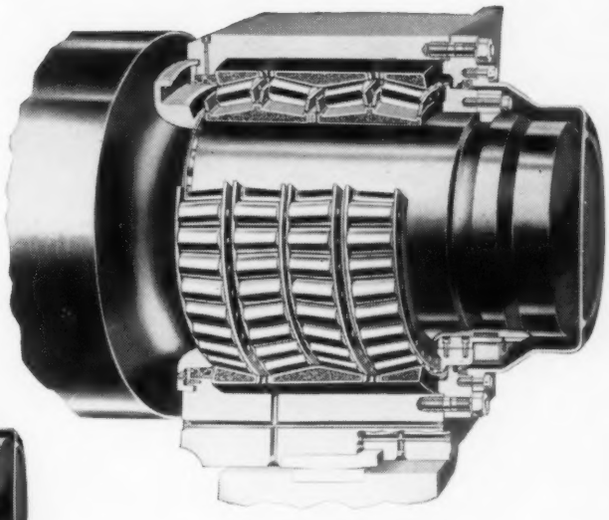
As shown in Figure 6, between two adjacent stands, there are located a micrometer 13 which gives an electrical signal on the output lines 14 in accordance with the thickness of the strip 15 between those stands, and a device for giving an electric signal proportional to the linear speed of the strip as it passes between the stands. This device consists of a disk 16 mounted on the rotor of a tachometric generator 17, the arrangement being such that the plane of the disk 16 is alined with the direction of motion of the strip 15 and the disk rotates at the same peripheral speed as the strip.

A second device for measuring the speed of the strip is located at the issuing side of the last roller stand 12a.

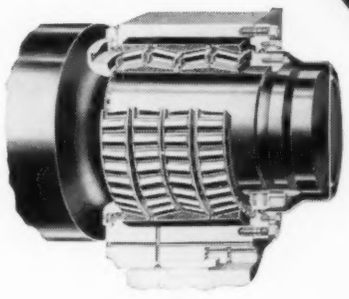
Figure 6



TIMKEN® bearings used on rolling mill roll necks



1958
1,008 mills



1950
317 mills

1933
45 mills

Look how this idea has grown in 25 years!

JUST 25 years ago—in 1933—there were 45 mills using Timken bearing-equipped stands. Today, 2,436 Timken bearing-equipped stands are used in 1,008 mills . . . more than 22 times as many mills as in 1933.

Why has the idea of using Timken® tapered roller bearings on mill roll necks become so widely adopted? For all these reasons:

1. LOW BEARING COST. Tonnage records indicate that the long life of Timken roll neck bearings keeps bearing costs per ton of steel rolled to a minimum.

2. GREATER MILL RIGIDITY. Balanced proportion design of Timken bearings permits larger roll necks than ever before possible with tapered roller bearings.

3. ELIMINATION OF COMPLICATED LUBRICATING SYSTEMS. Timken bearings permit use of simple grease lubrication.

4. LOAD RATINGS INCREASED UP TO 40% due to Timken bearings' balanced proportion design.

5. NO SPECIAL THRUST BEARINGS NEEDED. Timken tapered roller bearings take both radial and thrust loads.

6. MILLS CAN BE STOPPED AND RESTARTED WITH NO LOSS OF STEEL. Timken bearings permit starting under full load.

7. HIGHER ROLLING MILL SPEEDS are possible because Timken bearings minimize friction.

8. PROLONGED ROLL LIFE is assured because Timken bearings provide maximum roll neck strength, less wear.

You can be sure of all these advantages in either existing or new equipment by specifying Timken tapered roller bearings for back-up and work rolls. Consult our roll neck bearing specialists for full details. Write The Timken Roller Bearing Company, Canton 6, Ohio. Canadian plant: St. Thomas, Ontario. Cable address: "TIMROSCO".

This symbol on a product means its bearings are the best.

TIMKEN
TRADE-MARK REG. U. S. PAT. OFF.

TAPERED ROLLER BEARINGS ROLL THE LOAD

NATIONAL stopped brush breakage!

TRADE-MARK

DOWN-TIME COULD HAVE COST THIS POWER COMPANY A FORTUNE!

"RED" BLACKBURN

Power companies kept reporting threading and grooving of the steel field rings on giant turbine generators. The result was eccentric rings and *severe brush breakage,* says "National" Carbon Brush Man "Red" Blackburn.

And, he continues, a turbine off the line for reconditioning can cost a fortune in power replacement — not to mention repair expense.

"Red" suggested using "National" Grade 634 Brushes. Comparative tests showed this brush eliminated threading, grooving and resisted breakage and chipping when applied to eccentric rings.

Do you have a brush problem? Call *your* "National" Brush Man. Or, write to National Carbon Company, Division of Union Carbide Corporation, 30 East 42nd St., New York 17, N. Y.

UNION CARBIDE

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NATIONAL CARBON COMPANY • Division of Union Carbide Corporation • 30 East 42nd Street, New York 17, N. Y.

Sales Offices: Atlanta, Chicago, Dallas, Kansas City, Los Angeles, New York, Pittsburgh, San Francisco. *In Canada:* Union Carbide Canada Limited, Toronto.

More than paid for itself in...

20 MONTHS!

A steel mill installed this Green Aerodyne Dust Collector to prevent coal dust wear on the blades of their new turbo-blower.

This turbo-blower ran 24 hours a day, 7 days a week, for 20 months.

Then, for the first time, it was shut down for inspection. They removed the top to inspect blade wear. Did the blower need a reblading job—a job that would cost much more than the total installation costs of the Green Aerodyne Dust Collector?

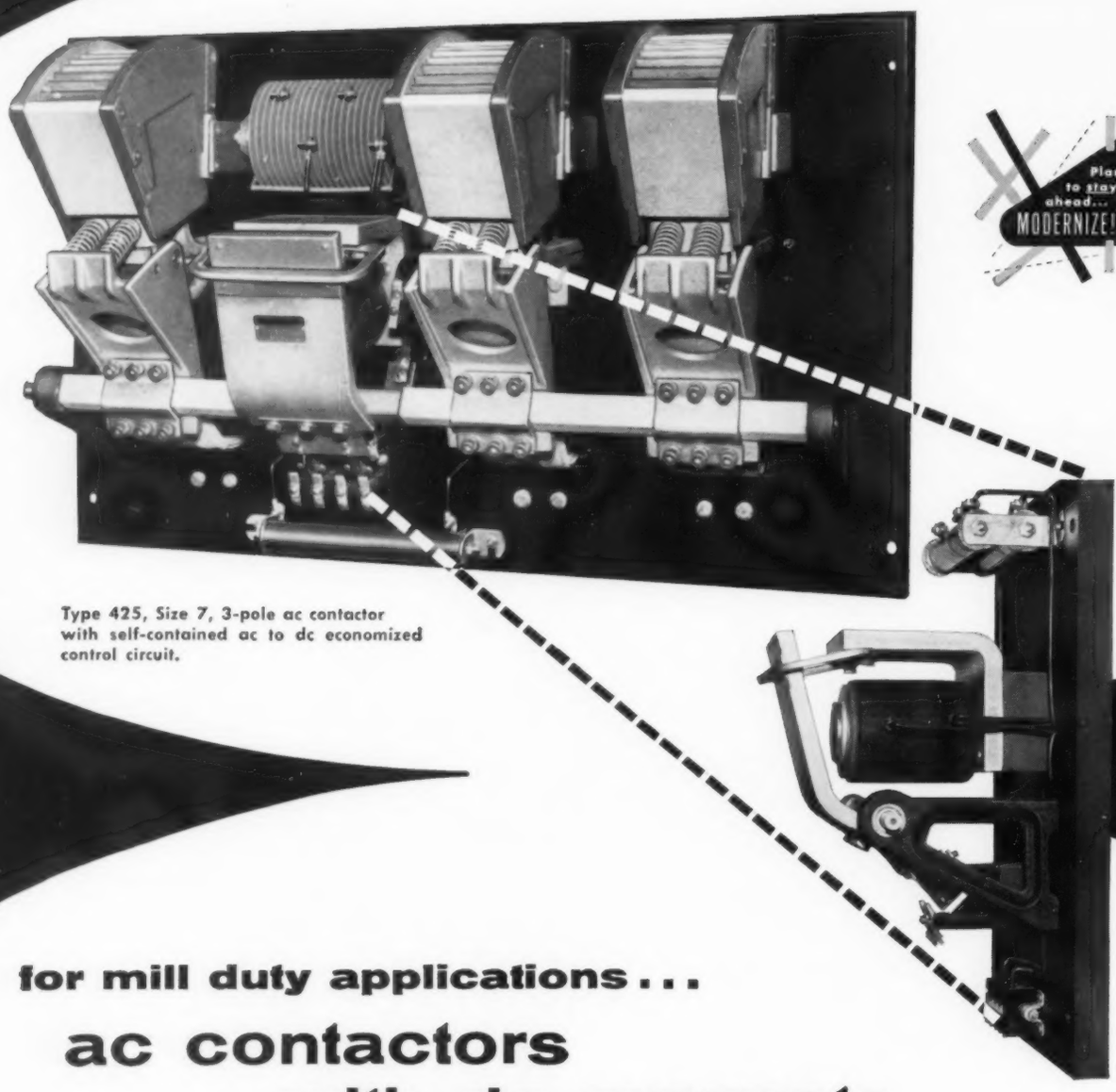
No. They just re-installed the top ond ordered the turbo-blower back into continuous operation and ticketed the next inspection 18 months hence.

Oh yes, when will the Aerodyne Dust Collector wear out? Nobody seems to know. Its life-in-use seems to be practically unlimited.

★*These Green Aerodyne Dust Collectors really do their jobs. Might save you a considerable sum, too. We'd be happy to show you how.*

Green

THE GREEN FUEL ECONOMIZER CO., INC. BEACON 3, NEW YORK



Plan to stay ahead... MODERNIZE!

Type 425, Size 7, 3-pole ac contactor with self-contained ac to dc economized control circuit.

for mill duty applications...

ac contactors with dc magnets

dc operation offers these advantages:

- Not affected by dirt and corrosion
- Quiet operation — minimum wear
- Wide pickup and operating range
- Low inertia design
- Low operating burden

All Allis-Chalmers ac contactors, from Size 4 through 8, are available with dc operation. The advantages this offers, combined with clean-cut, simplified construction and the longer contact and arc chute life of ACBO Arc Centering Blowout, are your assurance of contactors that will withstand the heavy demands of mill duty service.

Whenever you specify low voltage starters, be sure to get these long-life features provided by Allis-Chalmers contactors. It is these contactors that make the complete range of Allis-Chalmers starters the dependable performers they are.

Get all the Facts

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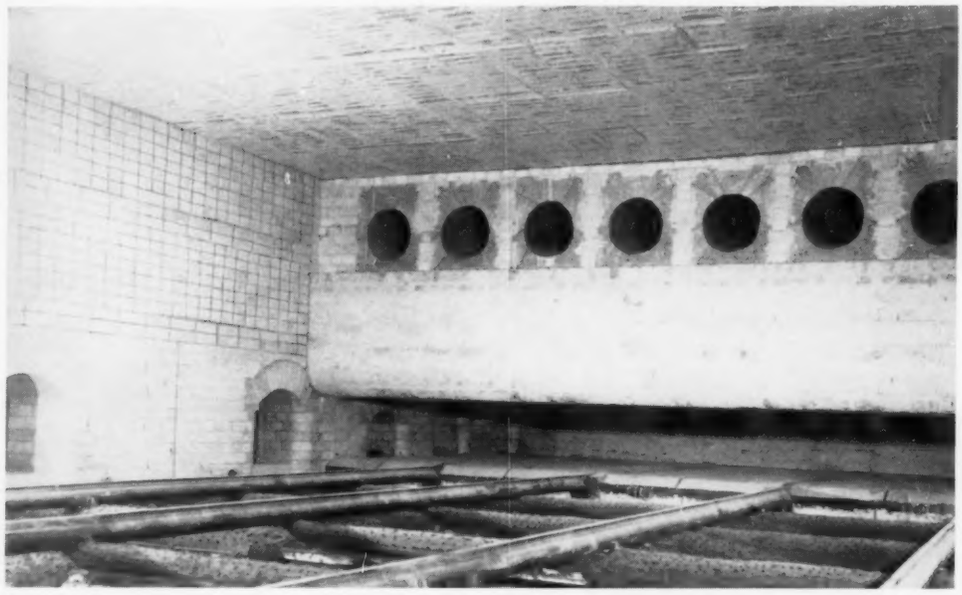
THE INTERLOCKING ARCH and SMALL RADIUS NOSE

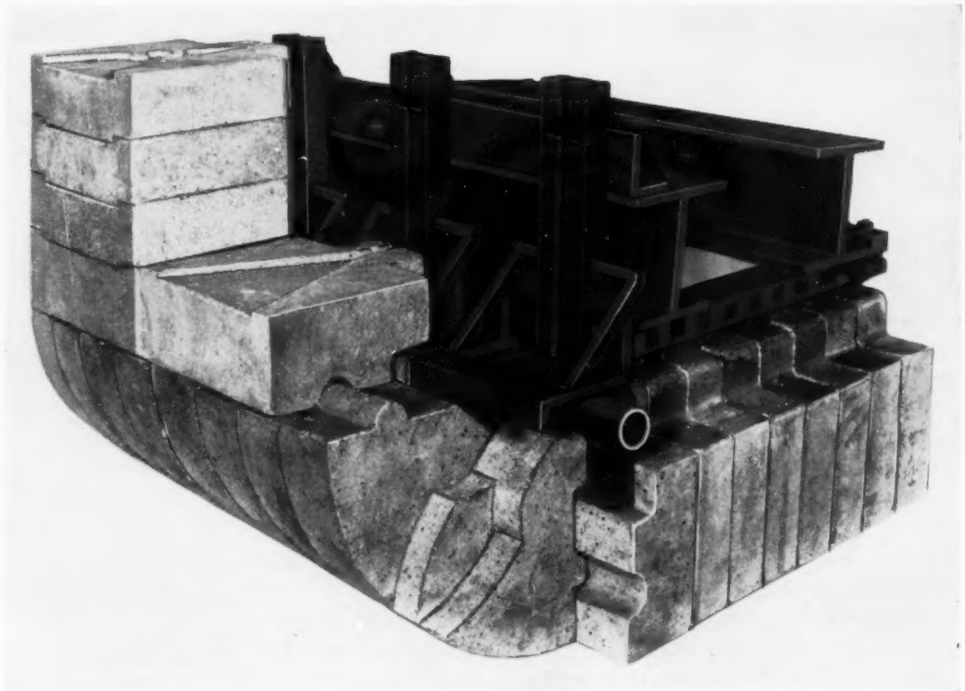


All red letter items are serving the Cleveland Works of the Jones and Laughlin Steel Corporation.

Our equipment is in service on the three furnaces at their 77" Hot Strip Mill. Photo to left shows an inside view of the suspended roof and small radius nose which encloses the heavily fired heating chamber of a typical Rust triple zone type furnace. Our bundle method of suspension and malleable iron hangers are producing a service life of three years on these high temperature zones.

with CLAW TYPE BRACKET and WATER PIPE COOLING

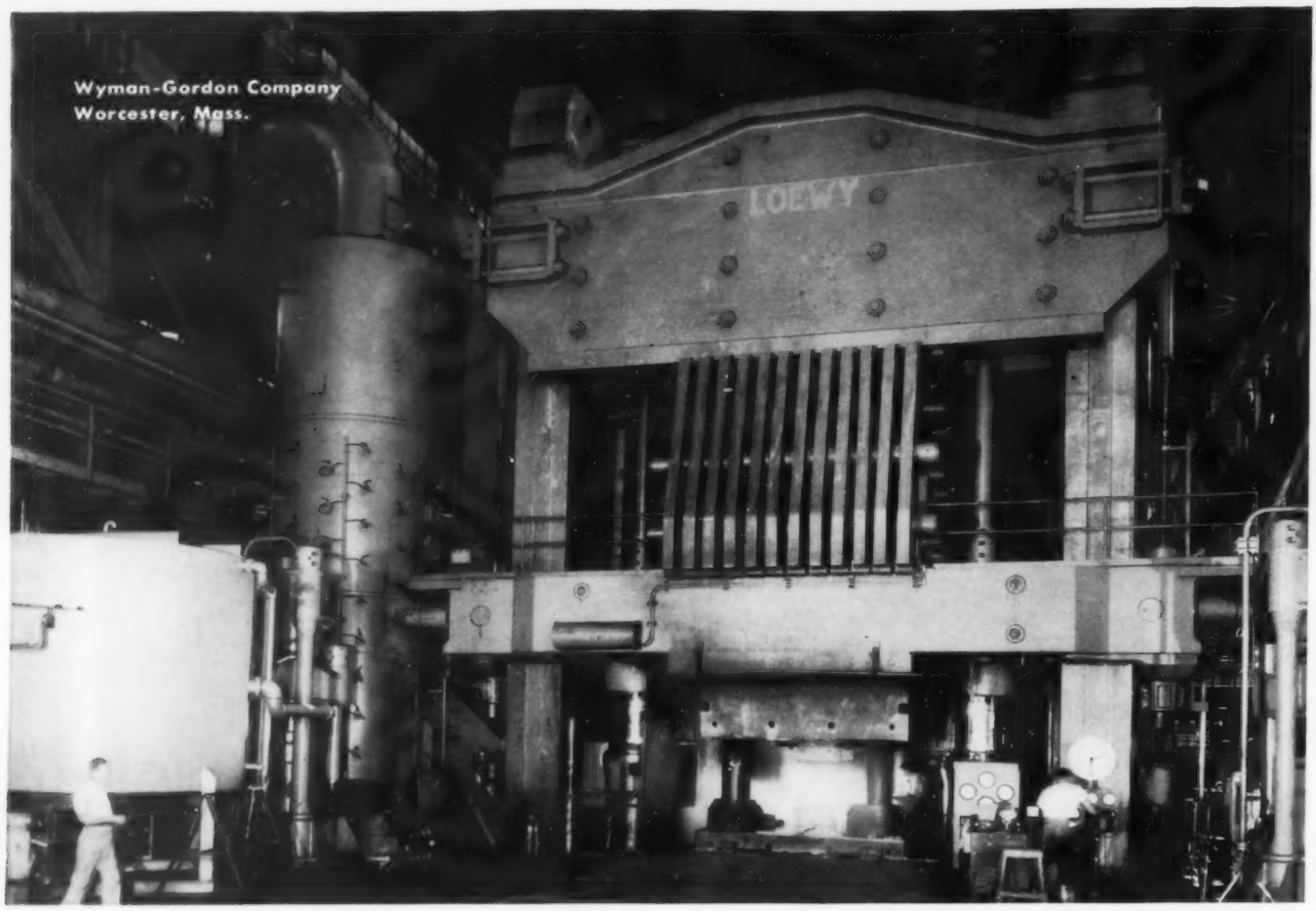
Photo to right shows how the 2 rows of nose tiles are enclosed within the Claw Type bracket which supports and protects them against any pinching or over loading. The water pipe as shown can be added when additional cooling is needed to preserve the nose under heavy duty operation. These two improvements have greatly increased the service life of our nose to the point where it is now equal to the suspended roof. Service-wise we now have a well-balanced furnace



Interlocking Arch Department, L. S. Longenecker, Mgr.

FRAZIER-SIMPLEX, INC.

436 EAST BEAU STREET • WASHINGTON, PENNA., U. S. A.



Operation Big Squeeze:

World's largest presses lubricated by Cities Service Pacemaker Hydraulic Oils

Once a forging operation for horse-drawn carriages, Wyman-Gordon Company now operates the world's largest presses, with the newest one capable of exerting 50,000 tons pressure.

Reason for this tremendous press is the increasing need for strong, lightweight metal parts for aircraft. Today, as for many years, no military or transport aircraft takes to the air without Wyman-Gordon forgings.

With its huge, hydraulically operated presses, Wyman-Gordon is able to forge huge pieces with one big squeeze. Sometimes a whole unit for a landing-gear strut. Or one mammoth wing spar.

The press that exerts 50,000 tons pressure is described by Wyman-Gordon as "the largest single machine ever conceived"—and few people would argue the point after seeing it.

Mounted in a pit that extends nine stories beneath the earth, the giant press is over 114 feet high and weighs 10,605 tons, 6,450 of which moves up and down.

Cities Service is justifiably proud that here as in all of Wyman-Gordon's presses with 18,000 tons pressure or better, hydraulic lubrication is provided by Cities Service Pacemaker Oils.

It is hardly necessary to point out the incredible demands that such machinery makes of its hydraulic lubricants... and certainly it is self-evident that if Cities Service Pacemaker Oils can perform satisfactorily in the world's largest presses, they'll do the same for you. Talk with a nearby Cities Service Lubrication Engineer. Or write: Cities Service Oil Co., Sixty Wall Tower, New York 5, N. Y.

Entire Rig Is Operated by One Man with the few simple controls shown here. With a flick of his fingers he can put on a squeeze of 50,000 tons. Result is extremely strong lightweight forgings for aircraft.

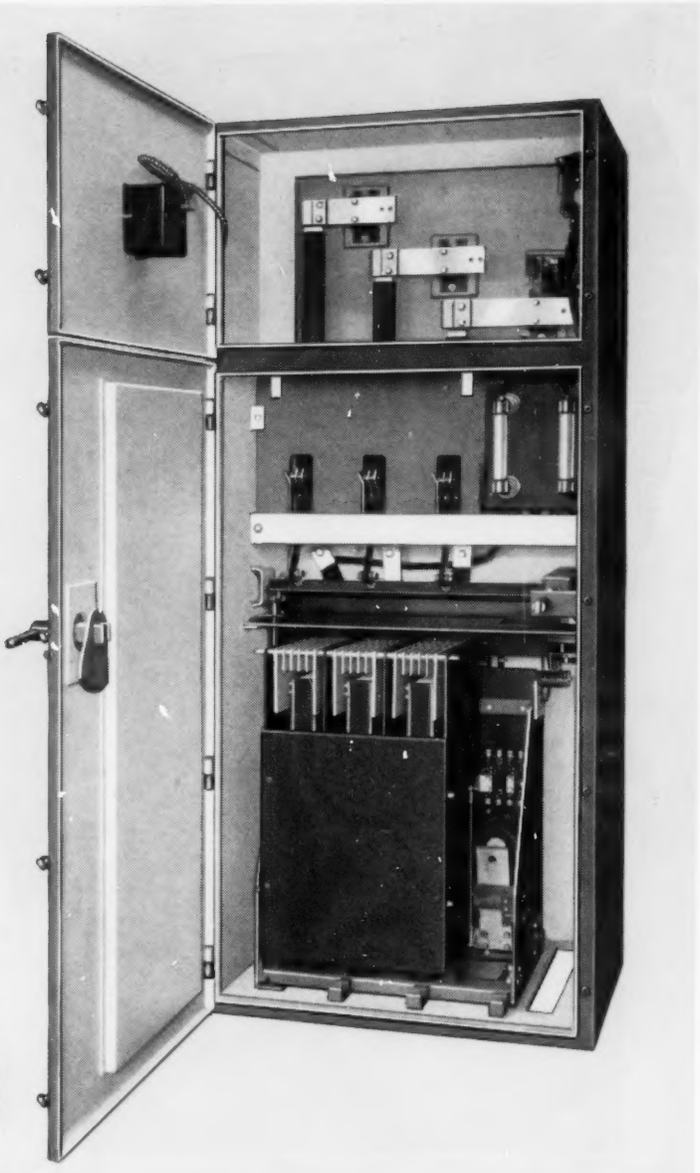
Lubrication Foreman has mammoth responsibility. Here, he checks dispenser for Cities Service EP 20 Lubricant... used on main bed and columns of large presses and other areas subject to extreme pressures.

CITIES SERVICE

QUALITY PETROLEUM PRODUCTS

NEW EC&M STARTER

GIVES 100/150 MVA fault protection



WITHOUT FUSES!

Proven by tests conducted by an independent testing station, EC&M's new "fuseless" ZHA air-break starter has a certified interrupting capacity of 100,000 KVA at 2400 volts, 150,000 KVA at 4800 volts. This starter is simpler and much more accessible for inspection and checking connections.

The ZHA starter is not subject to problems associated with fuses. Single phasing due to blown fuses is eliminated...no costly replacement fuses to stock.

For positive personnel safety, the ZHA is equipped with a 3-way doorlatch, interlocked between disconnect switch and contactor interlocking system. The disconnect switch is gang-operated. When the door is open, disconnect blades are *visible* in the open and grounded position.

No roll-out needed...phase barrier and arc-chutes draw out horizontally, making front and rear contact tips readily accessible. Bus bars are used for power connections throughout the starter. Redesigned arc-chutes and interphase barrier, and improved contactor are additional features which make the ZHA starter your logical choice for high-voltage motor drives.

***GET THE COMPLETE STORY** on certified fuseless fault protection for high-voltage motor drives. Write for Bulletin 8130*

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A DIVISION OF THE SQUARE D COMPANY
CLEVELAND 28 • OHIO

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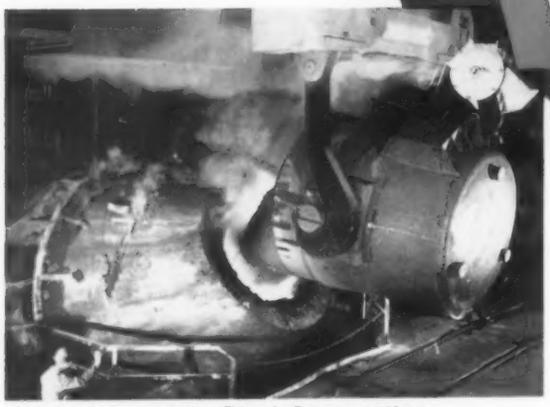

Jones & Laughlin Steel Corporation
Aliquippa Works

Kaiser Steel Corporation
Fontana Works

. . . MORE COMING!

In fact, PECor has fabricated all of the Basic Oxygen Furnaces that are in use or now being installed in America, including the major portion of the auxiliary equipment. When you have need of heavy machinery or equipment, rely on PECor's 75 years' experience in designing and fabricating for the steel, chemical, oil and other industries.

PENNSYLVANIA ENGINEERING CORPORATION

NEW CASTLE, PA.

OTHER STEEL PLANT EQUIPMENT WE BUILD

Blast Furnaces • Scrap Cars • Slag Cars
Oxygen Converters • Bessemer Converters
Hot Metal Mixers • Ore Transfer Cars
Ladles • Jack Cars • Ladle Transfer Cars
Ingot Cars • Mixer Cars • Thermo Metal
(Bottle) Cars • Scale Cars

PECOR

ELECTRICAL WHO'S WHO AT J & L, CLEVELAND—

World's Most Exciting Steel Mill

On January 1st, 1959, The W. W. Clark Corporation assumed all electrical construction operations of the Dingle-Clark Company—since 1918 noted for its large and complicated electrical installations, including those at Jones & Laughlin. Associated with Mr. Willis W. Clark, president and treasurer, are Vice Presidents C. A. Martin and C. W. Cristal and other management personnel.

THE WW CLARK CORPORATION

same management . . .
same personnel . . .
but a new name for intelligent electrical construction

ROLL CALL OF J&L ELECTRICAL JOBS

Major electrical construction installations in the Cleveland Works of Jones & Laughlin were planned and installed by the Dingle-Clark Company in cooperation with the contractors shown at the right. We are proud of these signal achievements which contribute to the efficient operation of these exciting new J & L mills and process lines. Now this same management personnel that has been responsible for these complete projects is associated with The W. W. Clark Corporation to provide the finest in electrical construction for American industry.

J & L ELECTRICAL INSTALLATIONS MADE FOR THESE CONTRACTORS:

American Bridge Company
A. E. Anderson Construction Corporation
Automatic Sprinkling Company
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Morrison Construction Company
Olson Construction Company
Ragnar Benson
Raymond Concrete Pile Company
Rust Furnace Company
Charles Schulz Building Company
Suburban Plumbing & Heating Company
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For Your Electrical Engineering Construction . . . Consult

THE W. W. CLARK CORPORATION

ELECTRICAL ENGINEERING CONTRACTORS

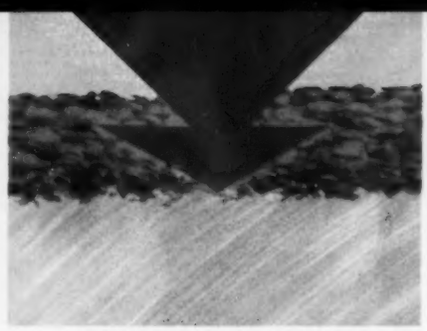
ENGINEERS BUILDING, CLEVELAND 14, OHIO

Pittsburgh: 311 Ross Street
Philadelphia: 1617 Pennsylvania Blvd.

You
the
RUST-OLEUM®
RUST PREVENTIVE
STOPS RUST!®
BEAUTIFIES AS IT

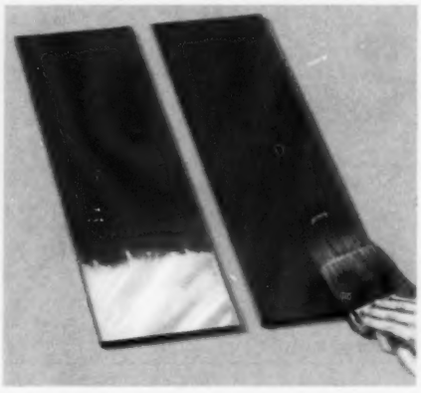
take brush!

Apply Rust-Oleum 769 Damp-Proof Red Primer directly over sound rusted surfaces. Saves costly surface preparations—lasts and lasts.



The **specially-processed** fish oil vehicle in the primer penetrates rust to bare metal—as proved in radioactive tracing studies.

Rust-Oleum, in its many forms, resists rain, fumes, heat, moisture, sun, and general weathering to stand up over the years.



Up to 30% more coverage with Rust-Oleum, depending upon the condition and porosity of the surface. Another Rust-Oleum difference.

See the many Rust-Oleum DIFFERENCES yourself!

Rust-Oleum primers and finish coatings are easily applied by spray. Flows smoothly . . . may be used in conventional, hot spray, or high pressure air-less spray.

A few easy strokes of the brush proves more than a thousand words . . . see how smoothly Rust-Oleum flows on . . . no pull, no drag . . . and it dries free of brushmarks. See, too, how much more coverage Rust-Oleum gives you . . . up to 30% more area depending upon the condition and porosity of the surface.

If your metal surfaces are *rusty* – simply brush or spray Rust-Oleum 769 Damp-Proof Red Primer right over the sound rusted metal after scraping and wirebrushing to remove rust scale and loose rust. The *specially-processed fish oil vehicle* in the primer penetrates rust to bare metal—driving out air and moisture. Easy as that to Stop Rust—and save time, money, and metal.

For *lasting beauty* – follow up with a Rust-Oleum finish coating in the color of your choice – from grays, greens, blacks, and aluminums to yellows, blues, whites, or browns – or from the many popular pastel shades.

That is the Rust-Oleum *System* of primer and finish coat for maximum over-the-years protection. A system that is measured by the money you save. Specify Rust-Oleum for maintenance, new construction, and re-modeling. Your Rust-Oleum Industrial Distributor maintains complete stocks for prompt delivery . . . he will be happy to consult with you on your coating problems.

What is your coating problem? What **color** do you need? Get lasting beauty in the color of your choice. Mail coupon for color charts.

SEND FOR FREE TEST SAMPLE! ATTACH TO YOUR LETTERHEAD!

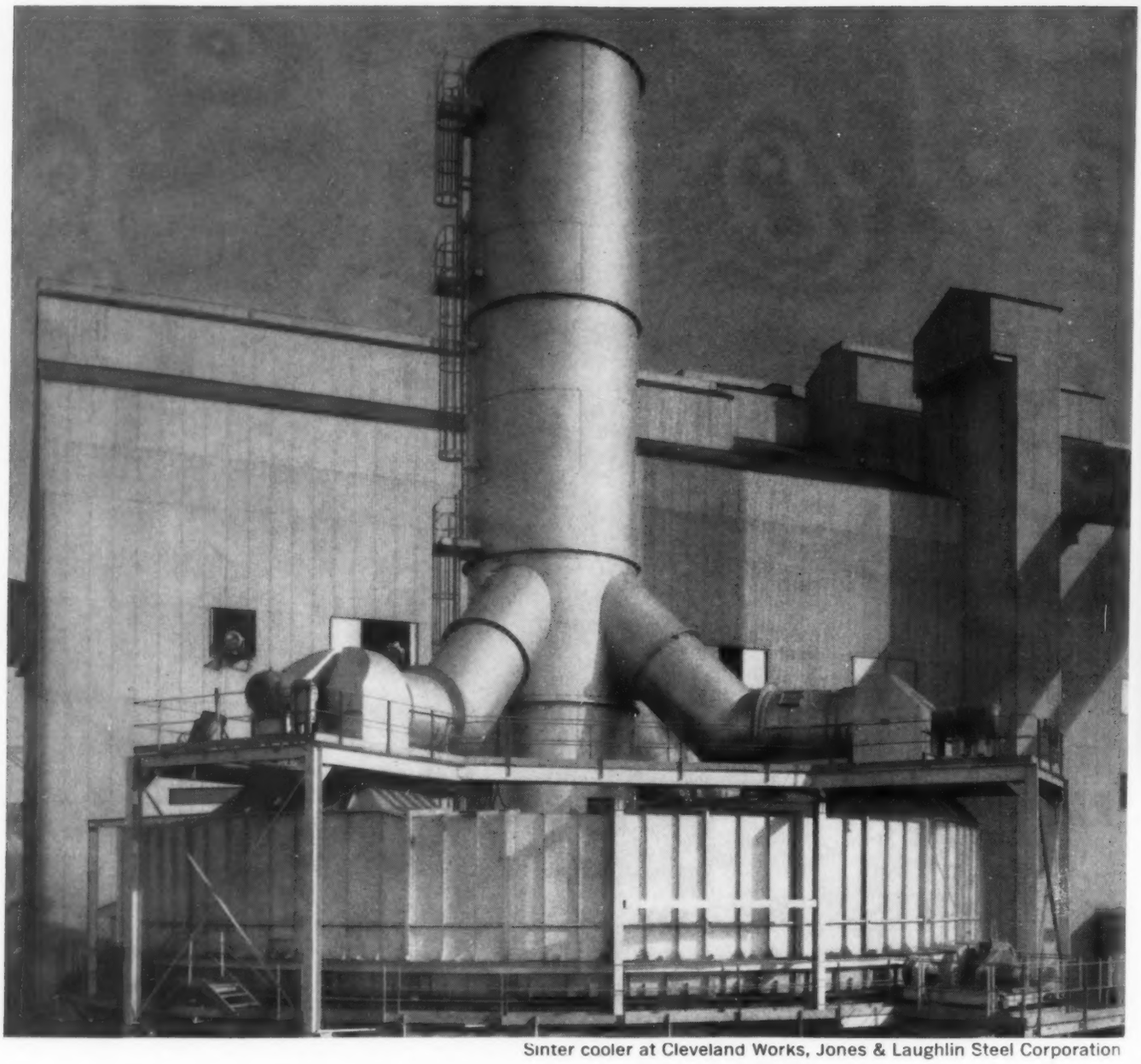
Rust-Oleum Corporation
2981 Oakton Street, Evanston, Illinois

Please send me the following at no cost or obligation:

- ☐ Free test sample of Rust-Oleum 769 Damp-Proof Red Primer for rusted metal surfaces.
- ☐ Complete literature with applications and color charts.
- ☐ Information on matching special colors.
- ☐ Thirty-page report on Rust-Oleum fish oil penetration.

SEE OUR CATALOG IN SWEET'S OR WRITE FOR COPY

A matter of excellence.
Distinctive as your own fingerprint.



Sinter cooler at Cleveland Works, Jones & Laughlin Steel Corporation

for maximum utilization of any sinter machine . . .

DRAVO-LURGI CIRCULAR AIR COOLERS

Dravo-Lurgi circular sinter coolers increase usable tonnage output in sintering operations by reducing shattering and dust.

This cooler puts a large volume of low velocity air-flow through a relatively thin bed of sinter . . . lowers temperatures to approximately 200 F at the discharge end, cool enough for conveyor handling.

See what these design features can mean to your operation:

- No water quenching to cause shattering, cracking, brittleness.
- No need for plows or scrapers at the unloading end.
- Sinter is undisturbed during cooling—minimizing sinter breakup.

Let a Dravo engineer demonstrate how Dravo-Lurgi sinter coolers (either circular or straight) can increase *usable* tonnage in your operation. Contact DRAVO CORPORATION, PITTSBURGH 22, PENNA.

DRAVO

CORPORATION

DRAVO LURGI

Blast furnace blowers • boiler and power plants • bridge sub-structures • cab conditioners • docks and unloaders • dredging • fabricated piping foundations • gantry and floating cranes • gas and oil pumping stations • locks and dams • ore and coal bridges • process equipment • pumphouses and intakes • river sand and gravel • sintering plants • slopes, shafts, tunnels • space heaters • steel grating • towboats, barges, river transportation

YOUNGSTOWN PIPE TRAVELS via ENTERPRISE

ENTERPRISE Pipe Handling Machinery in Youngstown Sheet and Tube Co's. New Mill:

1. Stretch Mill Decelerating Conveyor
2. Inlet Table
3. Heavy-Duty Middle-Cut Saw
4. Cooling Racks
5. Discharge Conveyor

ENTERPRISE equipment begins inside the furnace with water-cooled rolls feeding billets to the stretch mill. The decelerating conveyor, 283 feet long and consisting of 63 individually driven rolls, takes the pipe from the stretch mill at 1250 fpm. Limit switches decelerate the entire line and start rotation of 33 starwheels that discharge the pipe via an inclined ramp and rotating cams to the centering rolls. Centering for the hot saw is accomplished by 206 feeler limit switches, and 33 rotating turrets carry the pipe through the saw and dump it on the chain drag cooling bed. The lead and trail crops are picked up on a double line of individually-powered rolls, and discharged down a ramp to the transfer conveyor which completes the trip to a straightening machine. A rotary crossover bridges a set of rolls which are used only when cooling and sawing are unnecessary. This new mill at Youngstown Sheet & Tube Co. delivers 2⅜" to 5½" O.D. in lengths of from 75 to 150 feet.

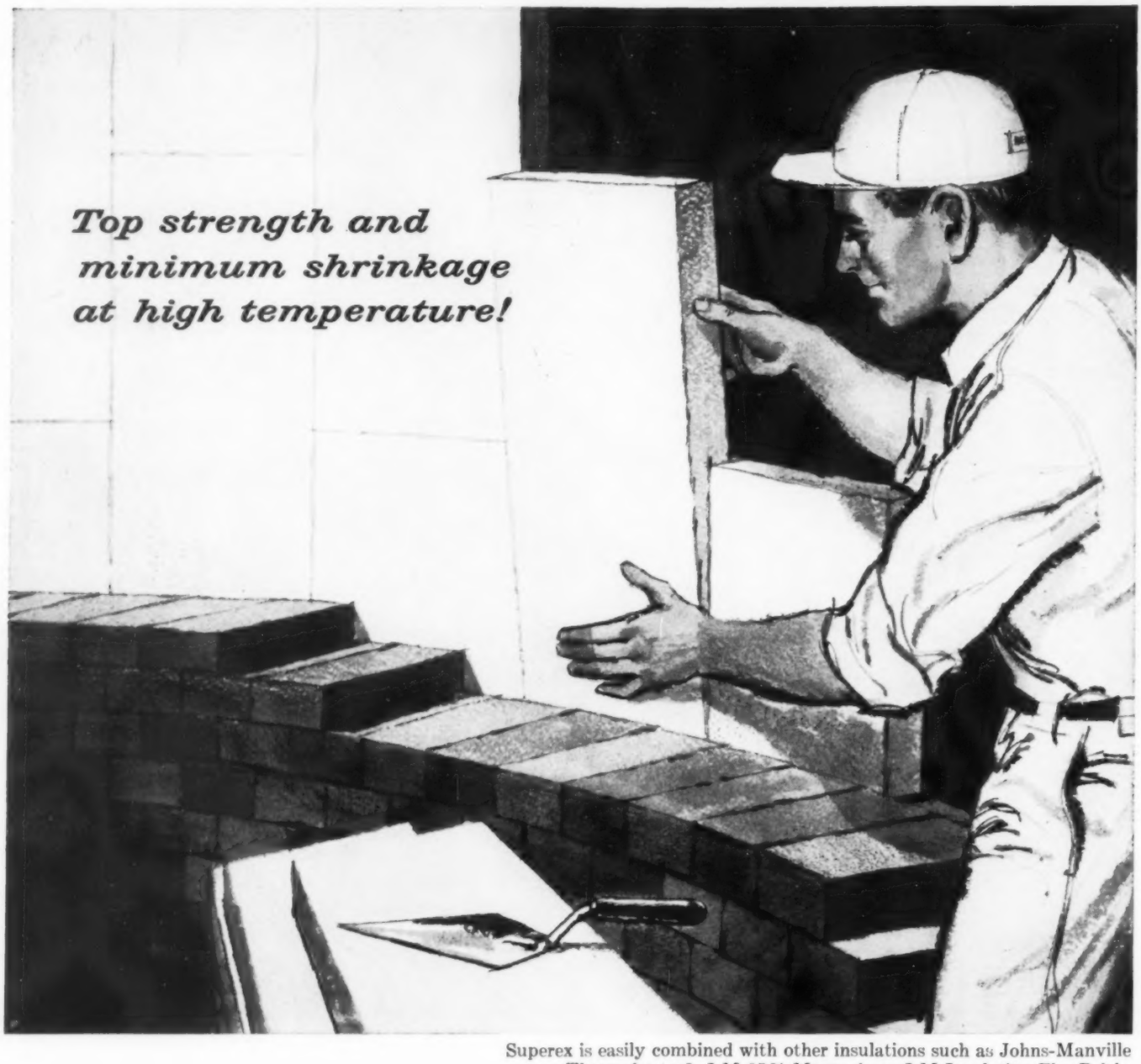
ENTERPRISE has been engineering and building machinery since 1878.

ESTABLISHED 1878

THE ENTERPRISE COMPANY

COLUMBIANA • OHIO • U.S.A.

CONVEYOR SYSTEMS,
AUTOMATIC HANDLING TABLES,
MILL-TYPE SAWS, SHEET AND PLATE LEVELERS,
SPECIAL STEEL MILL MACHINERY.



Superex is easily combined with other insulations such as Johns-Manville Thermobestos®, J-M 85% Magnesia or J-M Insulating Fire Brick.

After a quarter century . . .

there's still no substitute for J-M Superex insulation for service to 1900F!

In many ways, Superex® is the finest block insulation yet developed for high temperature furnace applications!

Made of diatomaceous silica and asbestos, Superex offers exceptional heat resistance—excellent insulating value. And at high temperature its stability is unsurpassed: it combines low shrinkage with excellent thermal effectiveness . . . easily withstands the physical abuse encountered in normal service.

Superex also speeds and simplifies installation. *Easy-to-handle*—Superex weighs only 2 lbs. per sq. ft. per inch thickness. *Strong*—it compresses only ⅛ inch under 6 tons' pressure per square ft. Superex is available in a wide variety of shapes and sizes . . . is easily cut with an ordinary knife or saw.

For further information write to Johns-Manville, Box 14, New York 16, N. Y. In Canada, Port Credit, Ontario.

For medium temperature applications, specify J-M Superex M blocks . . . for temperatures to 1600F.

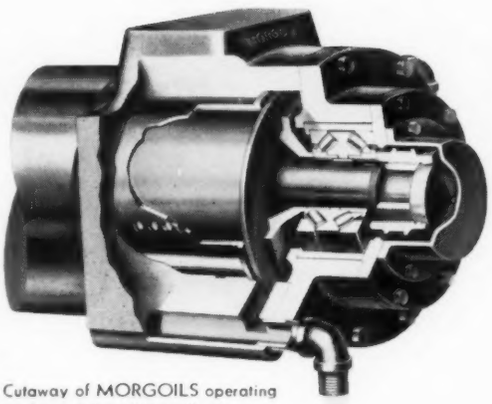
Saves waste. Superex comes in 7 standard thicknesses from 1" to 4". Other sizes available on order.

JM PRODUCTS

Johns-Manville INSULATIONS *FOR LASTING THERMAL EFFICIENCY*

MATERIALS • ENGINEERING • APPLICATION

LONG LIFE
and HIGHEST LOAD CAPACITY
with MORGOILS



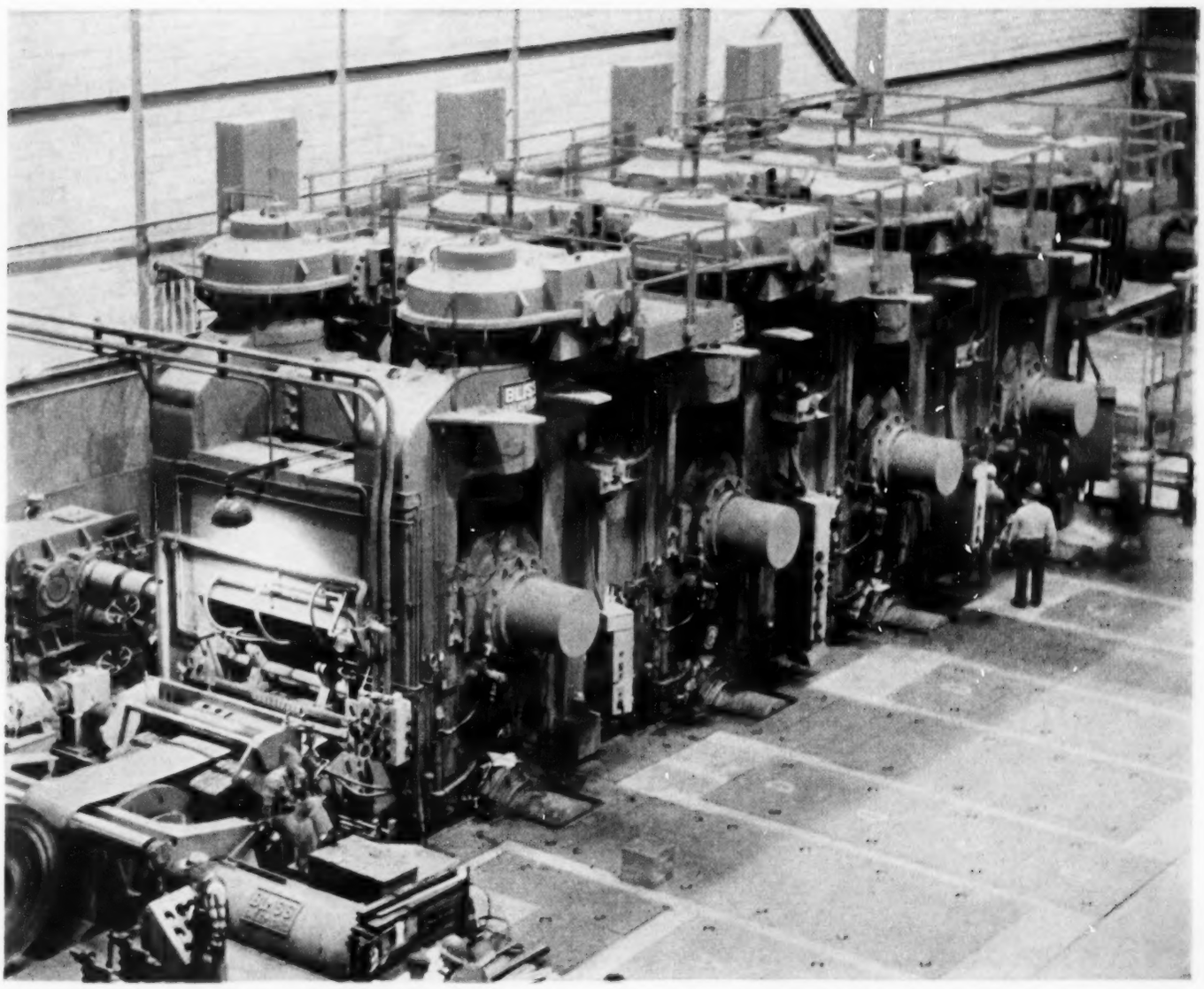
Cutaway of MORGOILS operating on Jones & Laughlin mill pictured below

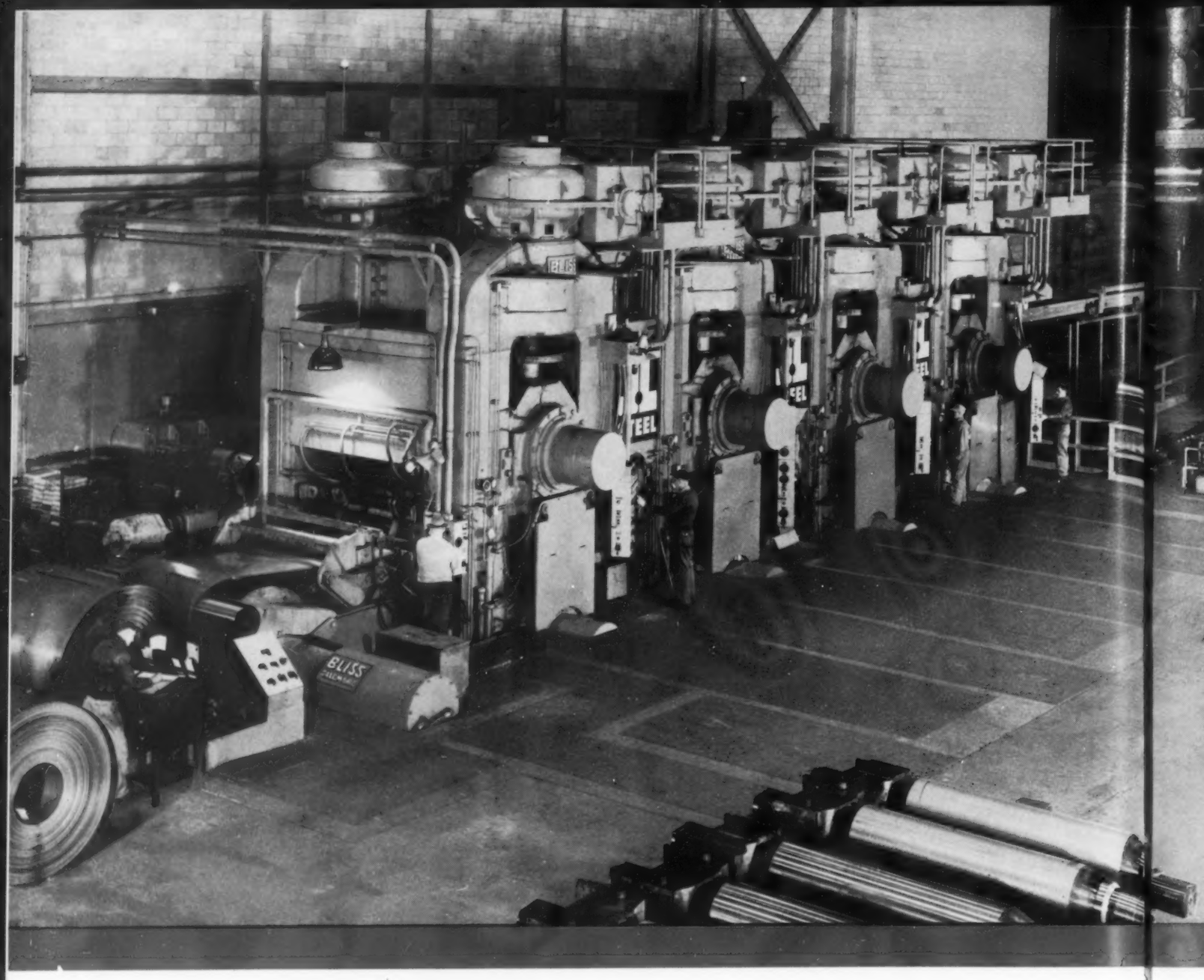
MORGOIL BEARINGS have kept pace with a dynamic industry by providing more load capacity than any other roll neck bearing . . . with proven ability to stand up under punishing high speeds. MORGOILS are proving their worth every day on the "World's Fastest—Most Powerful Four-Stand Tandem Cold-Reducing Mill" at the Jones & Laughlin Steel Corporation's Cleveland Works.

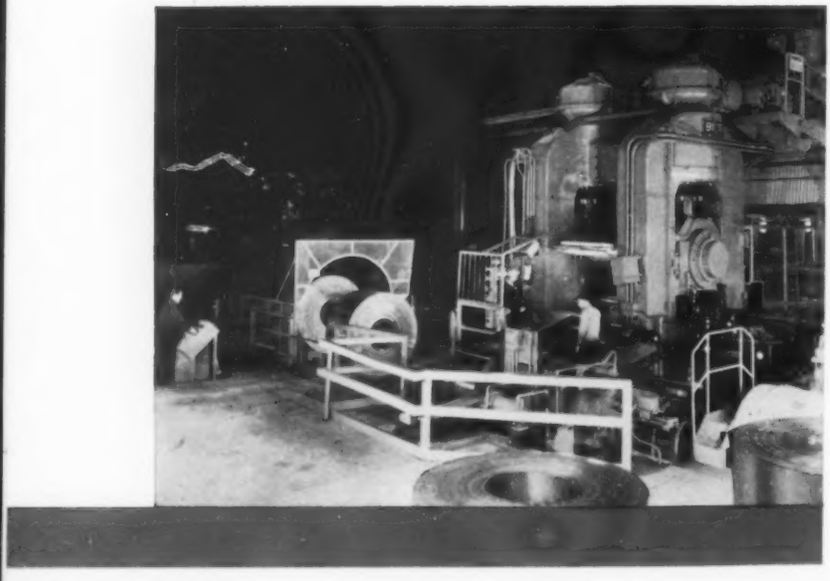
High quality sheets are finished on the companion SHEET TEMPER MILL. Oil spotting is eliminated by the modern inboard end of their MORGOILS.

MORGAN CONSTRUCTION CO.
WORCESTER, MASSACHUSETTS

Rolling Mills - Morgoil Bearings - Gas Producers
Wire Mills - Ejectors - Regenerative Furnace Control

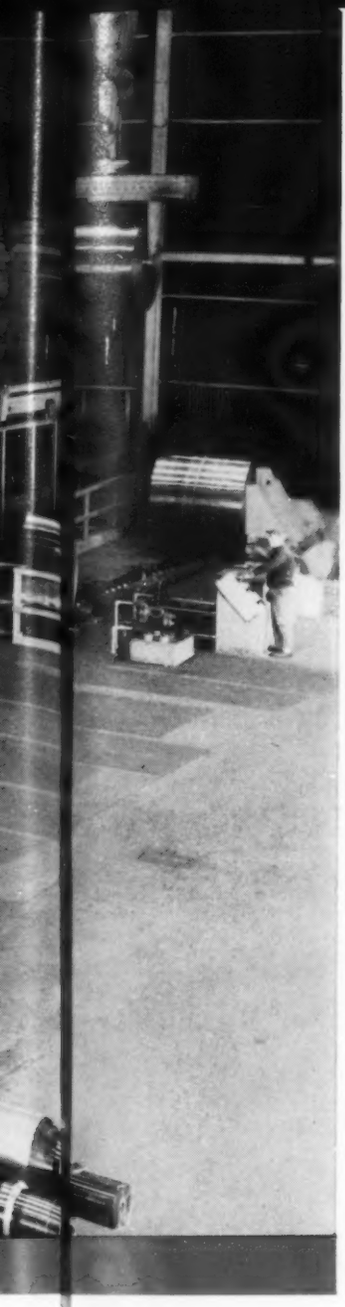






World's fastest four-stand cold reduction mill (3800 fpm—40 mph), it's also the world's most powerful (24,000 hp); features drives and controls on each roll. It is capable of rolling 70,000 tons of sheet a month, about double the capacity of the mill it replaced. The mill rolls coils weighing up to 60,000 lbs. and can produce sheets to 72″ wide.

Temper Mill is also important new performer at J & L's Cleveland Works. It is 19½″ and 53″ by 56″, has a top speed of 3500 fpm.



OPERATION "TURN-KEY" AT JONES & LAUGHLIN

From foundation to operation, Bliss assumed the role of "turn-key" contractor, supervising the construction and installation of the new cold rolling mills at the Cleveland Works. This involved—

- designing and building the world's fastest and most powerful four-stand tandem cold reducing mill
- designing and building a four-high temper mill
- supervising the modification and extension of the original cold rolling plant without disturbing operating equipment
- planning and supervising construction of the new annealing facilities for the Cleveland Works
- supervising sub-contracting of *all* equipment installation for the project.

To fulfill its contract, a staff of Bliss coordinators, amply backed by Bliss experience and J & L staffs, supervised the activities of many sub-contractors, keeping a hand in the thousand and one seemingly unrelated steps that go into the simultaneous modernizing of an old plant and the building of a new one. The assignment was considered "complete" when, in October of last year, Bliss "turned the key over" to J & L operating management.

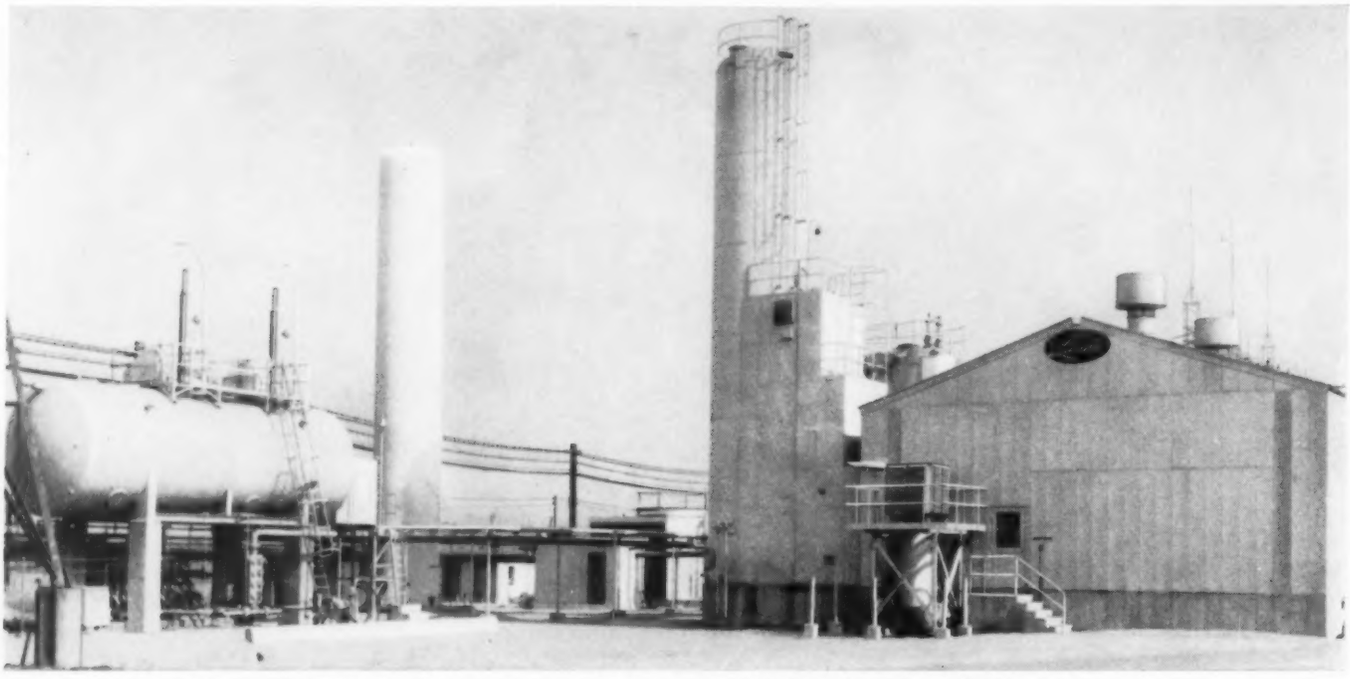
BLISS
SINCE 1857

Bliss is more than a name... it's a guarantee

E. W. BLISS COMPANY, Rolling Mill Division, Salem, Ohio

Subsidiary: The Matteson Equipment Company, Inc., Poland, Ohio

The exciting new J & L sets its pace . . .



This LINDE On-site Plant is located at J & L's Cleveland Works. Capacity—48,000,000 cu. ft. mo.

and LINDE helps them keep it!

LINDE's Oxygen supply system and scarfing process are geared to production requirements at Jones & Laughlin's Cleveland Works.

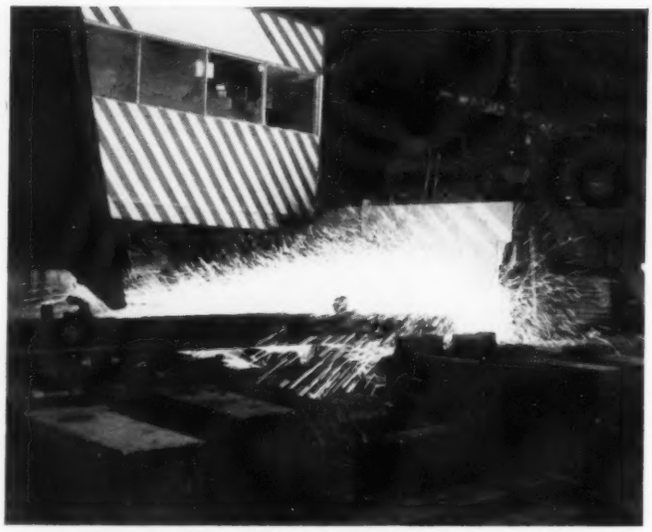
All oxygen demands—in the furnace and on the finishing line—are easily handled by LINDE's On-site Plant. BUT . . . intermittent demands require LINDE's flexible supply system—a reliable producing plant PLUS the ability to deliver "peak" and "back-up" requirements from a nationwide liquid oxygen producing and delivery system.

LINDE's supply system and scarfing process meet fluctuations in production as well. When demand dips the oxygen supply is immediately cut back and the LIN-DE-SURFACER Scarfing Machine is regulated or rolled off the line in a matter of minutes.

Whatever the pace set by J & L, LINDE is there right down the line helping to meet the schedule.

For further information, write Dept. IR-2, LINDE COMPANY, Division of Union Carbide Corporation, 30 East 42nd Street, New York 17, N. Y. Offices in other principal cities. In Canada: Linde Company, Division of Union Carbide Canada Limited.

The terms "Linde," "Lin-De-Surfacer," and "Union Carbide" are registered trade-marks of Union Carbide Corporation.



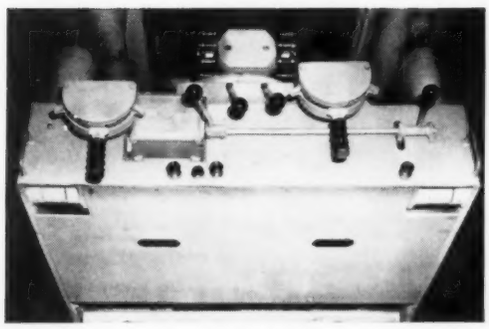
A LIN-DE-SURFACER Scarfing Machine, like the one shown here, is used by J & L to condition steel destined for the automotive industry.

Linde

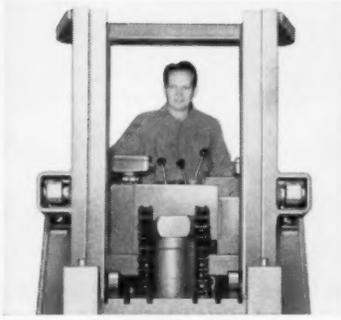
UNION CARBIDE

NEW ELPAR® TITAN

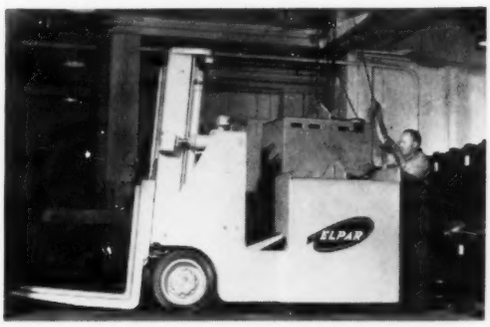
Titan quickly handles big loads in confined areas, moves easily through 7-foot box car doors.



Dual controls.



"Picture window" vision.



Easy access to batteries, rugged uprights.

From Every Angle... Unmatched for Heavy Load Handling

In 15,000 to 20,000-pound capacities, the *all-new* ELPAR Titan fork and ram truck series promises *all-around* handling efficiency:

For your production department, exceptional compactness, high travel and lift speeds, freight car maneuverability.

For your operator, clear visibility in every direction, dual controls, power steering.

For your safety department, ELPAR's new "Tri-Safe" braking system . . . three independent brakes—dynamic, hydraulic, mechanical—*act in sequence* and are controlled by a single toe bar.

For maintenance, quick battery change, trouble-free upright design, traditional ELPAR electric truck dependability.

ELPAR® ELECTRIC TRUCKS

Get the Full Story . . . SEND FOR TITAN SERIES BULLETIN and "TRI-SAFE" BRAKING BULLETIN

THE ELWELL-PARKER ELECTRIC COMPANY

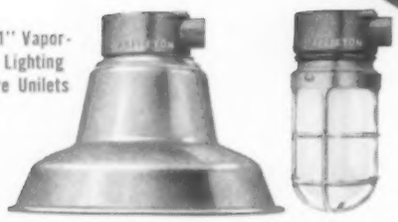
4539 St. Clair Avenue • Cleveland 3, Ohio

Twice the Life...1/3rd the Operating Costs

For every need . . .

"AE" Plug and Receptacle Series Unilets

"AE" Series 30, 60, and 100 ampere plugs and receptacles come equipped with solderless connectors and replaceable interiors. Choice of lift cover, or threaded cap types.

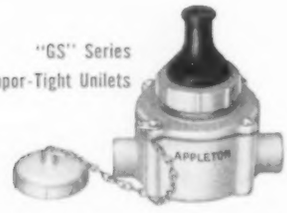


"V-51" Vapor-Tight Lighting Fixture Unilets

Vapor-tight lighting fixture series for use with rigid conduit. Known for its patented unit construction. Reflector and guard can be put on and taken off quickly . . . without tools! Designed for easy installation plus simple maintenance.

APPLETON®

Malleable Iron UNILETS®



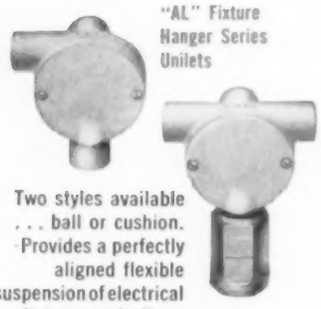
"GS" Series Vapor-Tight Unilets

Full line of vapor-tight covers. Bodies with or without mounting lugs, and variety of hub arrangements. Excellent for use with vapor-tight fixtures, switches, plug and receptacle housings, etc.

One of the most complete selections in the industry!

Yes, APPLETON can supply you . . . with a wide variety of Unilets for receptacles, switches, plain junctions, pilot lights, fixture hangers, etc. Ample wiring room. Assorted hub arrangements. *You name it, we've got it* . . . for indoors or out.

And every APPLETON product is made to the rigid quality standards pioneered by APPLETON engineers. They are easy to wire, are blemish free, have clean, chamfered threads conforming to N.P.T. requirements assuring a tight joint and positive ground. Next time you buy, specify APPLETON!



"AL" Fixture Hanger Series Unilets

Two styles available . . . ball or cushion. Provides a perfectly aligned flexible suspension of electrical fixtures and allows a swivel to 20° in any direction.

"FS" and "FD" Series Unilets

Weather-proof housings for junctions, receptacles and switches . . . for use outdoors or in. One, two, three and four-gang styles.

Form 35 Series Unilets

Threaded and no-threaded malleable iron series . . . taper threads . . . covers held by screws . . . will not vibrate loose . . . high quality finish . . . full line.

"JB" Series Vapor-Tight Unilets

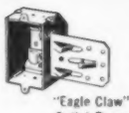
With or without mounting lugs. 4 tapped holes and 2 close-up plugs or blank body without close-up plugs. ½", ¾" and 1" sizes for use as "E", "C", "T", or "X" bodies.

Sold Through Franchised Distributors Only

APPLETON ELECTRIC COMPANY
1701 Wellington Avenue · Chicago 13, Illinois

Also Manufacturers of:

Explosion-Proof Lighting Fixtures



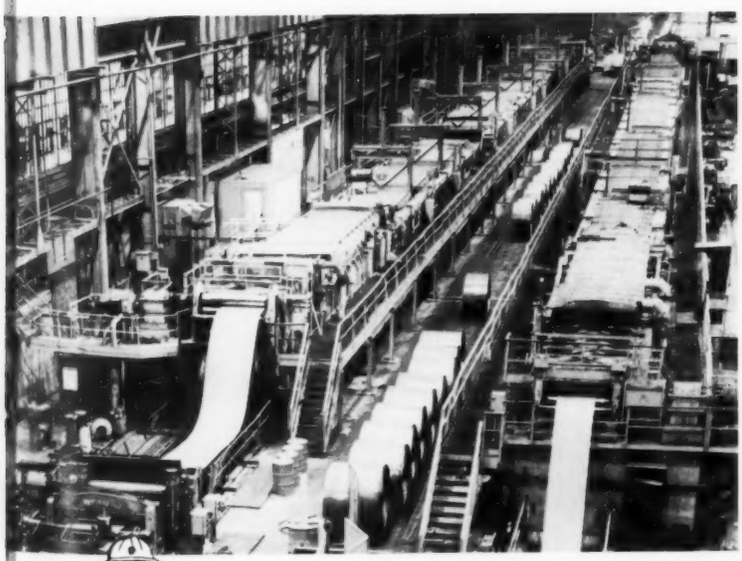
"Eagle Claw" Outlet Boxes

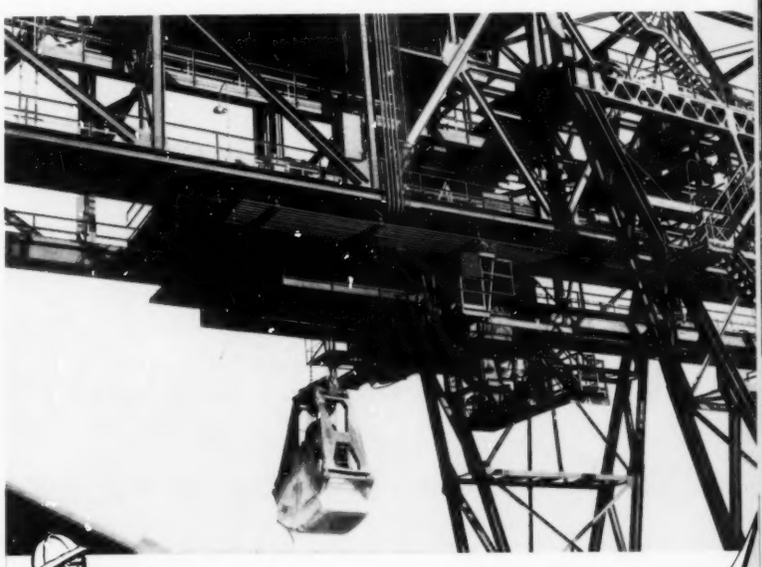
"ST" Series Connectors

Reelites

we are there

THE McDOWELL METHOD IS AT HOME AT J & L's CLEVELAND WORKS



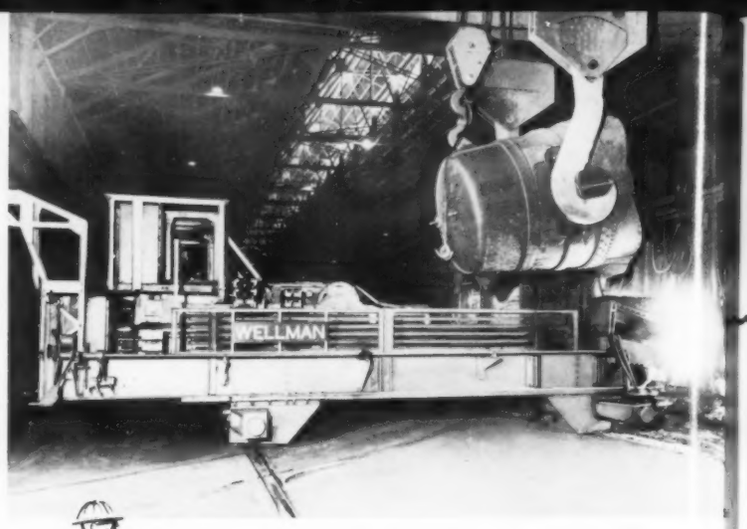


WE ARE THERE in the engineering and construction of foundations with complete installation of these Wean pickle lines.

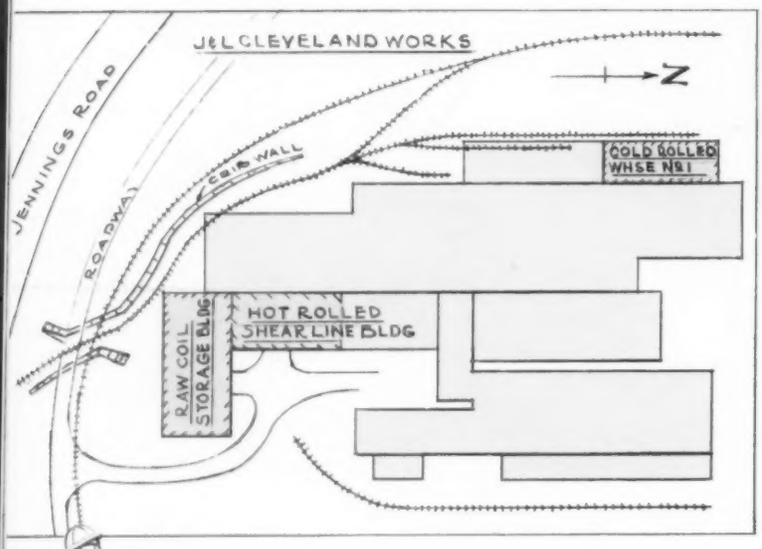
WE ARE THERE in the 17 ton Wellman ore bridge and the many Williams bulk materials buckets engineered and built by Wellman.

and

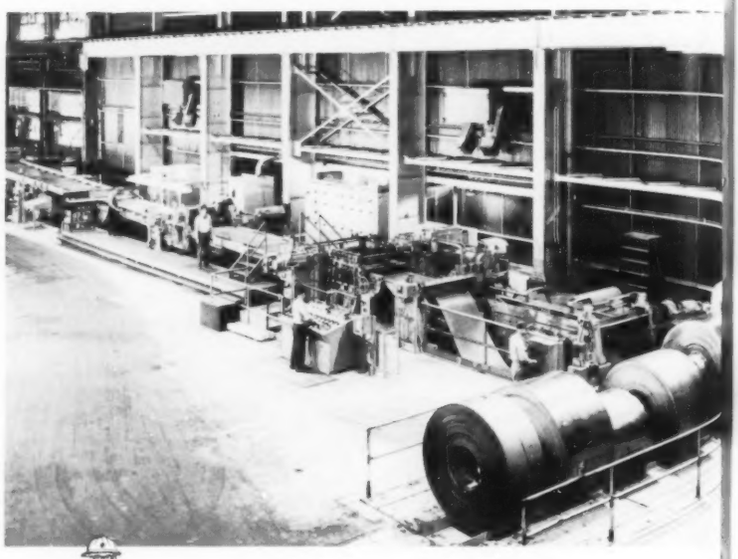
WE ARE THERE in the engineering and construction of foundations, and complete installation of the Wean hot rolled shear lines.



WE ARE THERE in the Wellman 12 ton open hearth charging machine, one of many Wellman has delivered to this plant since 1880.



WE ARE THERE in the many structures covering more than 125,000 sq. ft., McDowell-designed and constructed turnkey.



WE ARE THERE in the engineering and construction of foundations and complete installation of this Wean 48" cold shear line.

THE McDOWELL COMPANY FAMILY

Wellman Bulk Materials Handling Systems and Steelmaking Machinery • *McDowell Turnkey Plants*

Dwight-Lloyd® Research Laboratories • *Anker-Holth Power Cylinders*

Dwight-Lloyd® Ore Beneficiating Plants • *ABCs® Belt Conveyor Scales*

Williams Buckets • *Wellman Locomotive Cranes* • *Wellman-Galusha Gas Producers*

McDOWELL COMPANY INC., 113 ST. CLAIR AVENUE N. E. • CLEVELAND 14, OHIO • U. S. A.

Foreign Digests

Complete translations from which these condensations were prepared are available from Henry Brutcher, P.O. Box 157, Altadena, Calif., to whom all correspondence should be addressed.

"THIN-WALLED INGOT MOLDS FOR KILLED STEEL"

by A. M. DANILOV, Metallurgical Works, Zlatoust. (Translation No. 4242 from Metallurg, 1958, No. 2)

△ KILLED steel ingots are usually cast in big-end-up molds having walls considerably thicker at the bottom than at the top. There is a difference of opinion about the effect of mold wall thickness on ingot solidification and quality. Some think it useful to have heavy walls, others maintain that ingot structure is improved if the mold wall thickness is reduced; finally it is thought by still others that the wall thickness does not appreciably affect solidification, pipe, and segregation (within the usual range of thicknesses).

To study the effect of mold-wall thickness on structure and quality of ingots of alloy steel, ingots of open-hearth alloy steel weighing 4 net tons were poured in molds made with walls $2\frac{3}{4}$ and $5\frac{33}{64}$ in. thick by shifting the cores when casting the molds. No appreciable differences in structure were observed on fracture surfaces obtained of these ingots.

Next 4-ton ingots were poured in thin-walled molds with wall thickness constant along the whole mold length. No segregation was observed in these ingots.

After these preliminary experiments, a large-scale trial on the possibility of using thin-walled molds for casting ingots of high-grade plain carbon and of alloy steels was made. The steel was bottom poured into square-section molds on buggies, the ingots weighing 4.6 metric tons (5.1 net tons) and being 650 mm ($25\frac{1}{2}$ in.) wide at the top.

The new mold is of constant thickness all the way up (Figure 1). It is 2400 lb lighter than the ordinary one.

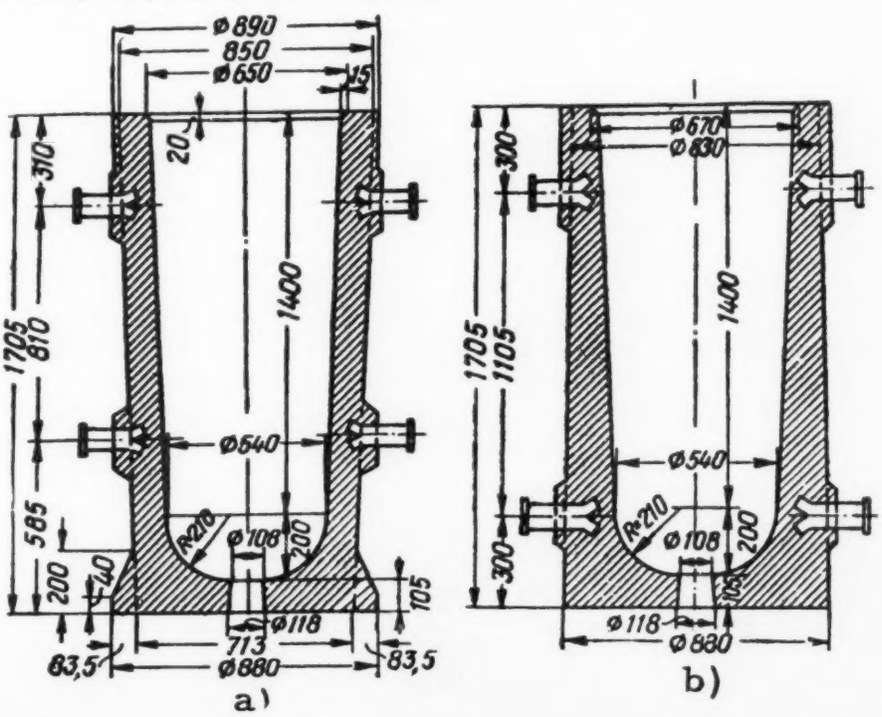
The new molds give about 10 per cent more pours. Both types of mold become unserviceable mainly because of longitudinal cracks (63–64 per cent), blowholes (25–27 per cent) and channeling of inner mold face (11–12 per cent).

Two ingots poured on the same stool, one in a thin-walled mold, the other in an ordinary mold showed identical crystal structure, compactness and segregation.

Results from 213 heats poured into thin-walled molds and 257 heats poured into ordinary molds showed that in the amount of pipe, central sponginess, general porosity and macrostructural defects, there was nothing to choose between the steel cast in the two types of mold.

Introduction of thin-walled molds

Figure 1 — Design and most important dimensions of molds for ingots: (a) thin-walled; and (b) ordinary wall thickness.



makes for a considerable saving. Mold consumption is reduced from 2.23 per cent on the weight of steel poured with the ordinary molds to 1.7 per cent with the new, a saving of 23.8 per cent.

Hence for producing large ingots, thickness of the mold wall should be selected mainly from considerations about the mechanical strength of the molds.

"OPERATION OF BLAST FURNACES AT HIGH TOP PRESSURE"

by L. A. KUZ'MIN, Blast Furnace Superintendent, Cherepovets Metallurgical Works. (Translation No. 4243 from Metallurg, July, 1957, No. 7)

ΔAT the Cherepovets plant, there are two blast furnaces of 35,555 and 36,475-cu ft effective volume, designed for operating at top pressures up to 21 psi. Since April, 1956, No. 1 blast furnace has been working at a top pressure of over 14.2 psi. The charging of fluxed sinter (basicity = 1.15), the use of high top pressure, improved operational conditions in the furnace and the organization of labor have enabled the blast furnace coefficient to be lowered to 0.73 (see Figure 1).

[Translator's note: This Russian "blast furnace coefficient" is the working volume in cubic meters from the centerline of the iron notch to the rim of the large bell in the lowered position, divided by the number of metric tons of iron produced per 24 hours. This coefficient of 0.73 equals 23.5 cu ft per net ton of iron per 24 hr.]

Coke consumption has been reduced from 1500 to 1380 lb per ton of conversion iron, and from 1540 to 1460 lb per ton of foundry iron. In individual months of 1956, coke consumption per ton of conversion iron was reduced to 1340 lb per net ton and for foundry iron to 1400 lb.

Due to the nature of the burden slag volume per ton of iron is very high, varying from 1700 to 1960 lb per net ton of conversion iron and from 1400 to 1600 lb per net ton of foundry iron.

The comparatively low coke consumption with high slag volume is chiefly due to the use of self-fluxing sinter in the charge and to the smooth working of the furnace.

High top pressure enabled the rate of smelting to be increased from 50 to 62 lb per cu ft per 24 hr when producing conversion iron. A 1.4 psi increase in top-gas pressure in the range of 10 to 17 psi raised blast consumption by 1765 cfm while maintaining the former pressure drop (12.7 to 15.6 psi).

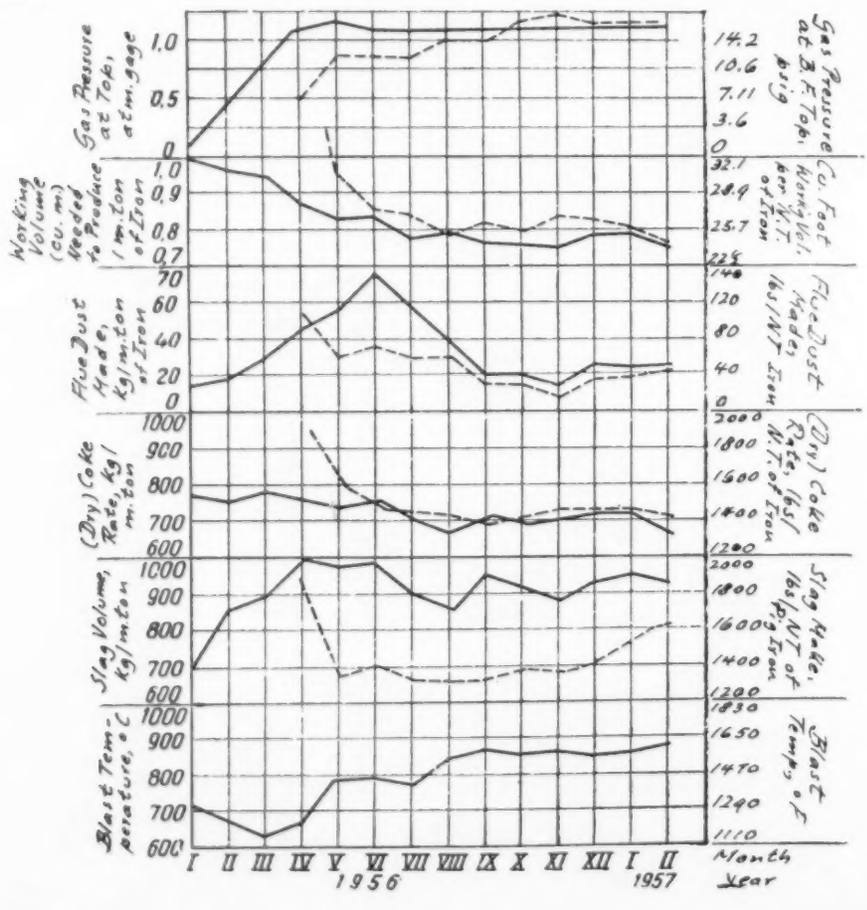
When top pressure was reduced for a short time to normal, furnace production fell off and the coke rate rose because blast volume and temperature were lowered. Furnace productivity was cut by 17 per cent while coke consumption rose by 4 per cent. This occurred in spite of the fact that the pressure drop averaged 1.4 psi more than normal.

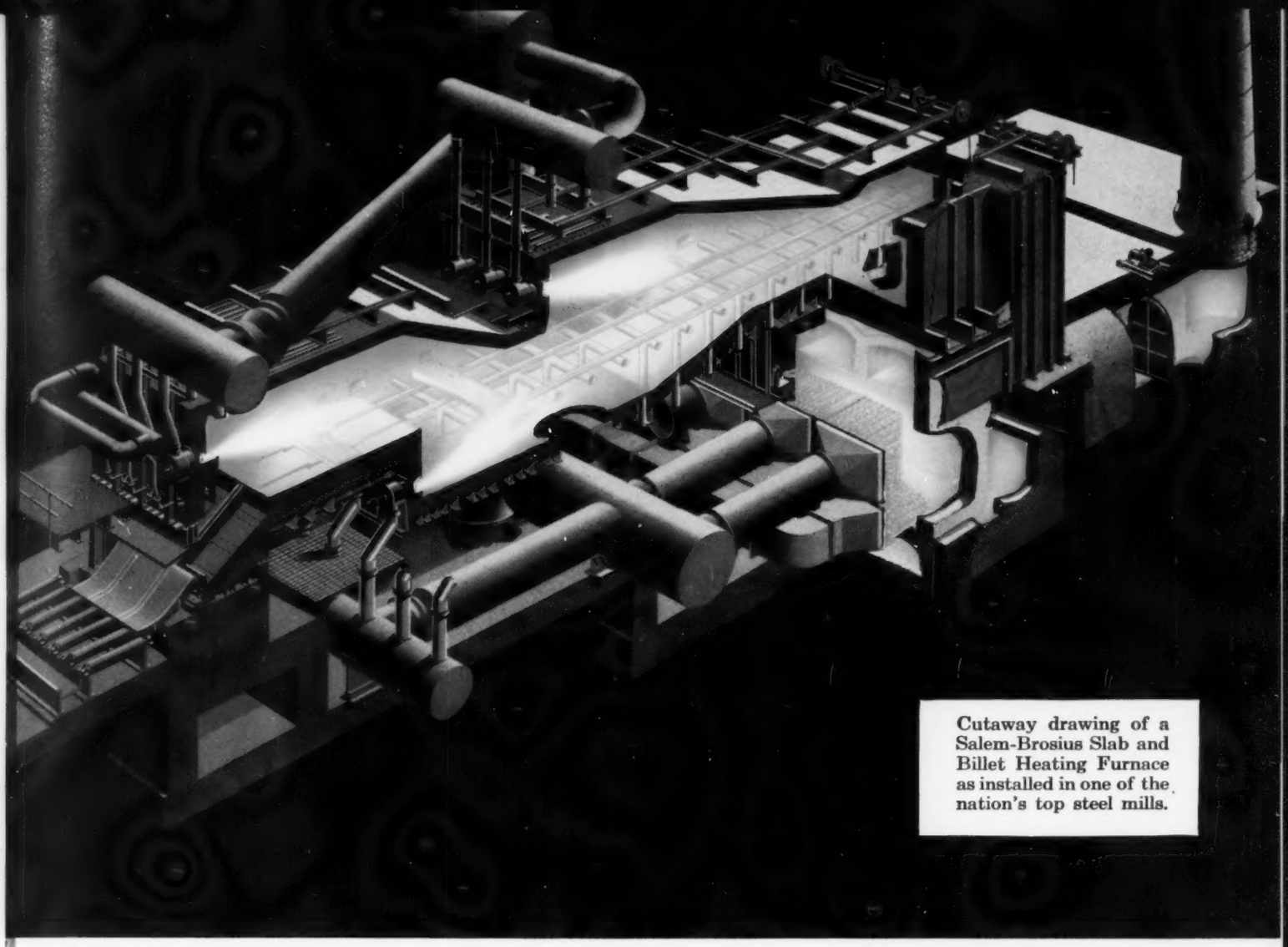
In recent months, the blast furnaces have been operating on high top pressure for more than 99 per cent of the total operating time. For fourteen months in 1956 to 1957, stoppages at the blast furnace plant were 0.7 per cent of the operating time, of which 0.2 per cent was for reasons directly connected with high top pressure operation.

TABLE I
Operating Variables of No. 1 Blast Furnace

Variables	February, 1956	March 1–26, 1956	April, 1956	May, 1956
Gas pressure at blast furnace top, psi	1.85	4.83	12.7	14.2
Furnace production, net tons per day	1138	1160	1279	1350
Smelting rate, lb coke per cu ft per 24 hr	48	50	55	56
Coke rate per net ton iron, lb	1504	1510	1528	1532
Iron content of sinter, per cent	57.8	57.4	56.7	57.4
Basicity of sinter	1.23	1.3	1.3	1.16
Slag make per net ton of iron, lb	1750	1820	1880	1860
Blast volume, cfm	53,200	53,670	60,760	60,025
Blast temperature, F	1280	1159	1340	1418
Temperature at furnace throat, F	510	563	554	500
Coke consumed, net ton of Fe in sinter, lb	1504	1500	1478	1464
Downtime, hours-minutes	5-27	2-03	3-13	2-04
Blast humidity, gr per cu ft	9.10	9.57	9.80	11.80
Carbon dioxide in gas, per cent	12.0	10.8	10.9	11.9
Pressure loss, psi	15.1	16.2	16.3	15.8

Figure 1 — Operating data on No. 1 blast furnace in the period of 1956 to 1957. Solid lines indicate production of basic iron; broken lines, that of foundry pig iron.


Gas Pressure at Top, atm. gage
Working Volume (cu. m) Needed to Produce 1 m.ton of Iron
Fine Dust Made, Kg/m.ton of Iron
(Dry) Coke Rate, Kg/m.ton
Slag Volume, Kg/m.ton
Blast Temperature, °C
Gas Pressure at Top, lb/sq. in. gage
Working Vol. Needed to Prod. 1 m.ton of Iron
Fine Dust Made, Kg/m.ton of Iron
(Dry) Coke Rate, lb/N.T. of Iron
Slag Make, lb/N.T. of Pig Iron
Blast Temp., °F
I II III IV V VI VII VIII IX X XI XII I II
Month
1956
1957
Year



Cutaway drawing of a Salem-Brosius Slab and Billet Heating Furnace as installed in one of the nation's top steel mills.

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Increasing the top pressure from 2.8 to 15.6 psi increased the production of No. 1 blast furnace for the period from January to April, 1956 from 1100 to 1355 net tons per day because of the increased rate of smelting. Flue dust made at 15.6 psi did not usually exceed 40 to 50 lb per net ton of iron.

Paralleling the increase in blast volume with top pressure of 15.6 psi, blast temperature was raised by an average of 180 F. A further increase in productivity at the same gas pressure was obtained mainly by increasing blast temperature to 1615 F and reducing blast humidity from 12 to 7 gr per cu ft.

Operational indices of blast furnace No. 1 are presented in Table I.

Because of smooth working of the furnace and the small amount of flue dust made, life of the top gear was improved. The top construction of furnace No. 1 lasted for more than one and a half years with the furnace operating on high top pressure for over a year. There are, at present, some slight leakages in this top construction which prevent pressure from being raised above 15.6 psi. When the top distributing gear is changed, the built-up big bell hopper will be replaced by a one-piece hopper.

After top charging gear and electric tap hole guns have been replaced by more powerful ones, top pressure will be raised to 21.3 psi.

Further increase in top pressure is limited by the poor heat resistance of the tyuere nozzle material. When these tuyere nozzles are replaced by heat resisting steel, blast temperature will be raised to over 1740 F, with moderate humidification.

"THERMOELECTRIC METHOD OF DETERMINING CARBON IN STEEL BATHS DURING HEATS MADE IN OPEN-HEARTH FURNACES"

by P. D. KORZH and A. P. ERSHOVA, Mining and Metallurgical Institute, Magnitogorsk. (Translation No. 4265 from Zavodskaya Laboratoriya, vol. 24, 1958, No. 1)

△ THE thermoelectric method, which is becoming ever more widely used in chemical analysis, has been used for determining carbon contents during the production of rimming steels in an open-hearth furnace.

Samples for such analysis must be uniformly quenched over the whole surface and should be quenched during pouring of the sample. Temperature for the quench should be the same for all samples.

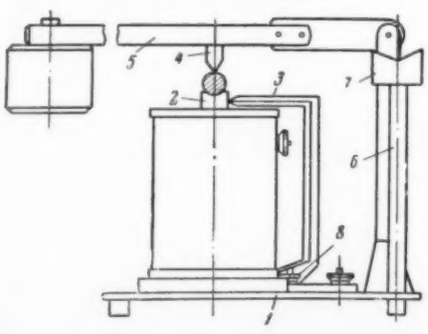
Several methods of quenching the samples were studied. Finally it was decided to sample with a truncated hollow steel cone which is inserted into a spoon containing liquid steel and rotated by hand. Then the cone, with a thin layer of steel adhering, is transferred to cold water. The whole operation takes only two seconds. The quenched sample can easily be detached, and generally actually falls off the cone.

Measurements were made with the apparatus shown schematically in Figure 1. The electrode (2) which is fixed to the marble base (1), is a copper cylinder with a V-recess in its upper surface. The body of the electrode (except the upper notched part) is enclosed and electrically heated.

Against the upper part of the electrode a copper-constantan thermocouple (3) is pressed for measuring the temperature of the hot junction, and an iron wire, serving as reference element. The cold electrode (4) is a brass rod, whose lower end is tapered to a point. It is fixed on an arm (5) which can rotate freely around the column (6). A counterweight is fixed on the end of the arm to press the specimen with a constant force against its support. Terminals (8) are fixed on the marble base for connecting a galvanometer into the thermocouple-potentiometer circuit for measuring thermo-emf.

The dependence of emf on carbon content was determined on specimens with differing carbon contents.

Figure 1 — Apparatus for measuring the thermo-emf (schematic).



Carbon contents were also determined by ordinary analytical methods. The thermo-emf of each sample against an iron conductor with the hot junction at 200 C was measured at five points. From mean emf and carbon content, a calibration curve was constructed showing variation of the emf with carbon content to be satisfactorily linear.

If the emf can be measured to within 0.01 mv, the error in carbon determination does not exceed ± 0.01 per cent.

"TOP BLOWING WITH OXYGEN IN BASIC CONVERTER"

by S. I. LIFSHITS and S. G. AFANAS'EV, Petrovsk Works and Central Research, Institute for Ferrous Alloys. (Translation No. 4267 from Metallurg, May, 1958)

△ THE shortcomings of acid converter steel produced by the orthodox pneumatic process are well known. With the object of obtaining metal equal in mechanical properties to open hearth steel, basic linings were installed in the acid converters of the Petrovsk plant. These were then adapted to oxygen blowing.

Oxygen is fed to the bath through a detachable inverted L-shaped, water-cooled lance with a cylindrical copper nozzle of $1^{21}/_{32}$ in. diam. The lance is raised and lowered by a winch with a rope drive and pulley system.

The converters are lined with magnesite-chrome (known as periclase-spinel) brick. The life of a lining 15 in. thick made of such a brick is 160 to 180 heats. Refractory consumption is 30 to 34 lb per net ton.

On the basis of the data presented in this paper, the following conclusions are drawn:

1. The rate of carbon drop in the first three minutes of the blow—until silicon is oxidized—is 0.171 per cent carbon per min. The rate increases later and attains high levels immediately after slag removal and at the termination of the blow.

2. Oxygen consumption for the oxidation of 0.1 per cent carbon during different periods of the process varies within wide limits.

3. Most of the phosphorus is

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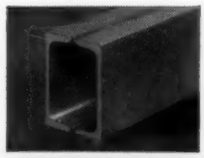
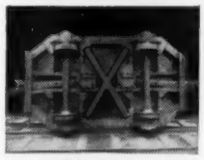
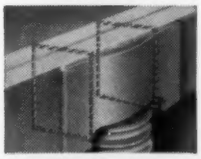


Box girder construction: Two channel sections, welded toe-to-toe, provide a frame far stronger than the ordinary angle or channel frame. This box frame is used under both the sides and ends of the car.

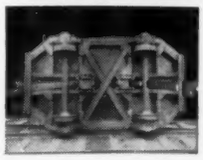
Double center sills: *Two* channels, back to back, run the entire length of the car. All cross members are welded to these sills, providing superior longitudinal rigidity.



X-frame bracing: These cross braces tie the box girder frame and the center sills together for additional strength and rigidity.



Spring pockets: Over each wheel, pockets are built into the bottom of the frame and "boxed in" on all sides. Coil springs are set into these pockets. This construction permits vertical, but no lateral, movement of the springs.



Long-shanked couplers: Pivot points of couplers are *behind* each axle. This permits turning the car on a short radius curve with less wheel flange pressure than with a short-shanked coupler.

USS

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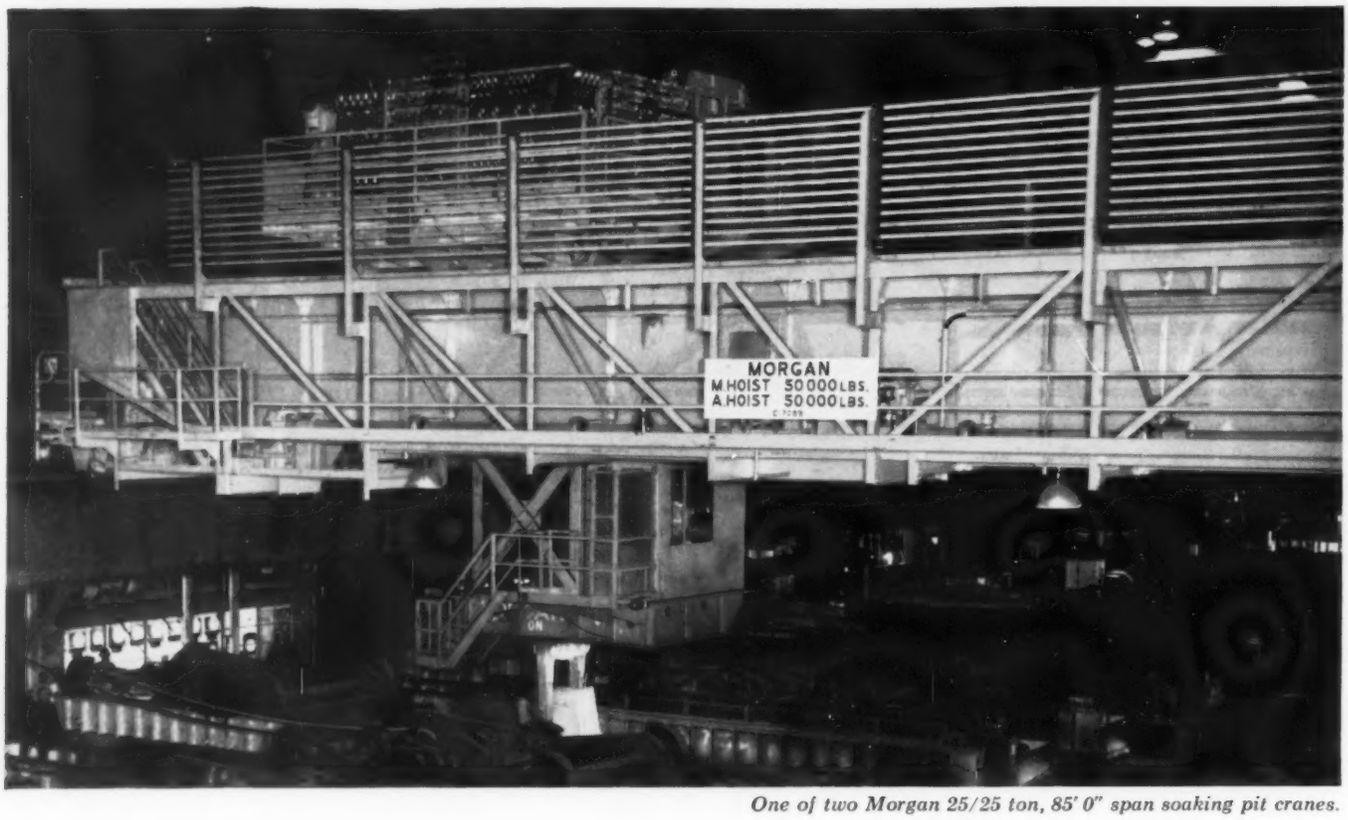

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removed in the first three minutes of the blow.

4. The reduction of manganese begins at the commencement of the second period (after slag removal and the building up of a new slag). At the end of the process when the carbon content is low, manganese is reoxidized and forms the "manganese hump" characteristic of the basic converter process.

5. Silicon is oxidized during the first few minutes of the blow.

6. Compared with the initial sulphur content, the sulphur content of the steel is reduced by only 26.3 per cent. After lime is added for building up the second slag, the sulphur content of the steel undergoes a slight increase.

7. The nitrogen content of the metal decreases during the progress of the blow.

8. Slag of normal basicity is formed in the last three to five minutes of the blow.

9. The increase in the amount of iron oxides at the end of the blow is caused by the oxidation of iron with diminishing carbon content of the metal.

10. The increasing magnesium content of the slag during the blow is evidence of marked reaction between the liquid bath and the lining.

OTHER AVAILABLE TRANSLATIONS

"Ingot Molds Chill-Cast of Magnesium-Treated Cast Iron," G. A. Pisarenko and Others. Stal', vol. 18, 1958, no. 7. Plant-scale trials of service performance of chill-cast ingot molds of magnesium-treated cast iron compared with ordinary gray iron molds for the open hearth. Principal causes of failure of chill-cast against ordinary ingot molds. Advantages of the former in regard to mold consumption, consumption of foundry supplies, fuel and labor costs. (Translation No. 4342)

"Fluxed Sinter with an Increased Magnesia Content," A. I. Gamayurov and A. G. Neyasov. Stal', vol. 17, 1957, no. 1. Pot sintering experiments to check earlier data on a beneficial effect of increased magnesia contents on strength and reducibility of fluxed blast-furnace sinter. Results of tests with special reference to strength and reducibility as function of MgO content. Relationship between increased MgO in fluxed sinter and the proportion of iron present in it as magnesite and hematite. (Translation No. 4087)

"Apparatus for Determination of the Reducibility of Blast Furnace Sinters," N. L. Gold'shtein and N. S. Khrochenko. Zavodskaya Laboratoriya, vol. 23, 1957, no. 11. Description of a compact apparatus for appraisal of sinter reducibility. Representation of results. Recommended working procedure. Time required for one determination: 35 minutes. (Translation No. 4264)

"Operation of the Hot-Blast Cupola," W. Haas. Die Giesserei, vol. 42, 1955. Suggestions of a practical nature regarding the operation of a hot-blast cupola: best volume, pressure and temperature of blast; waste gas temperature at entry to, and exit from, heat exchanger; bed coke volume; advantage of throwing limewater on coke bed; what to check before starting the blow. Make-up of charge and how it differs from charges for cold-blast cupola. Cupola care and maintenance; points to be considered. Materials economy of hot-blast cupola compared with conventionally operated cupola (Translation No. 3581)

"Effect of Increased Top Pressure [in Blast Furnace] upon Composition of Pig Iron Produced" V. L. Pokryshkin, Stal', vol. 17, 1957, No. 6, pp. 487–492. Effect of higher top pressures and concomitant changes in temperature conditions of blast furnace upon reduction of silica in the production of ordinary and high-silicon pig irons. Reduction of manganous oxide in pressurized blast furnaces. Absorption of carbon by pig iron. Influence of higher top pressures on working of furnace, coke rate, and on sulphur content of iron, the latter with special reference to the production of low-manganese pig irons. (Translation No. 4052)

"Experiences with Ingot Molds," F. Morawa. Stahl Und Eisen, vol. 51, 1931, No. 40 and 41. This is a reissue of the translation of a classic report of the Steelworks Committee, VDEh. It discusses functions of ingot molds, mold designs for killed and rimmed steels, ingot shapes for various production programs, mold wall thickness, effect of cross-sectional contour on structure, best taper for rimmed and killed steels, mold materials (cast iron, cast steel, alloys composition, water-cooled), mold handling, cooling practices, economics, mold life, ingot surface, etc. (Translation No. 35)

"Refining of Steel with Oxygen in a Rotating Furnace by the 'Kaldo' Process," B. Kalling and F. Johansson. Jernkontorets Annaler, vol. 141, 1957. Report on results (up to April, 1957) obtained. General features; furnace design and operation. Refining action; progress of heats. Materials best suited as coolants. Heat economy. Data on ingot yield compared with other processes. Furnace lining. Quality of steel produced. Production capacity (26-metric ton and 100-metric ton furnaces). Economics of process compared with basic bessemer process. Summary of advantages: economical conversion of high P as well as low P pig irons; effective sulphur removal; low nitrogen content of steel obtained; possibility of refining any kind of pig iron directly to steel of the desired carbon content. (Translation No. 4025)

"Prevention of Brown Fumes When Blowing Oxygen Through Steel Baths," G. S. Sel 'kin and N. I. Zadalya. Stal', vol. 17, 1957. Formation of brown fumes when blowing oxygen through steel baths in converter, open hearth, and electric arc furnaces, and resulting dust-elimination problems and damage to parts of the furnace system. Study of possibility of suppressing brown smoke by preventing development of extremely high temperatures in the zone of oxygen injection. Data on trial heats involving the injection of pure oxygen or an oxygen-water mixture with special reference to heat time lining wear, fuel consumption, and quality of steel produced. Arrangement for feeding water into the oxygen-injection system. Merits of water addition to oxygen in actual open hearth and converter operations and in the pre-refining of hot metal. (Translation No. 4056)

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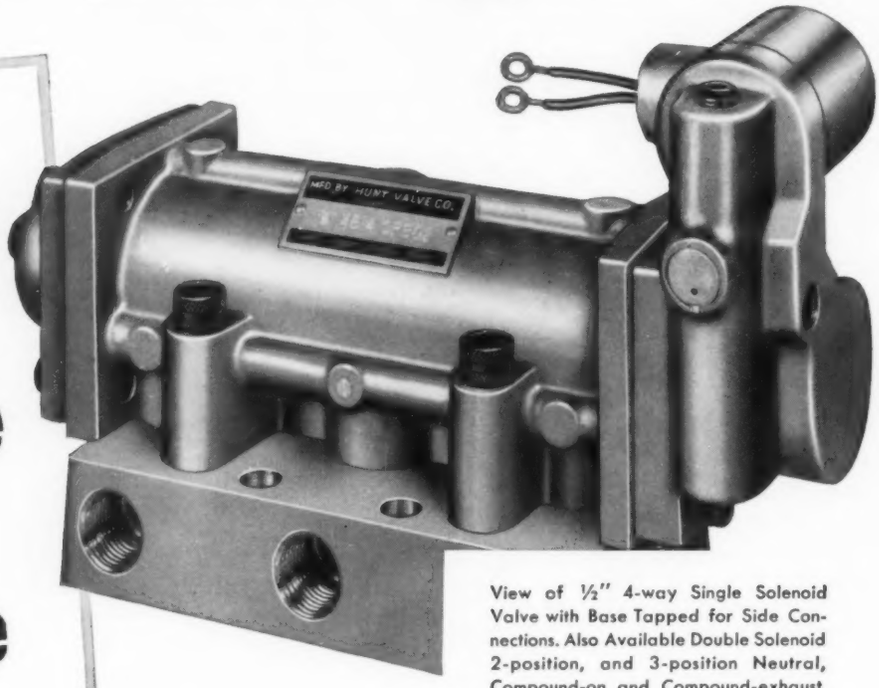

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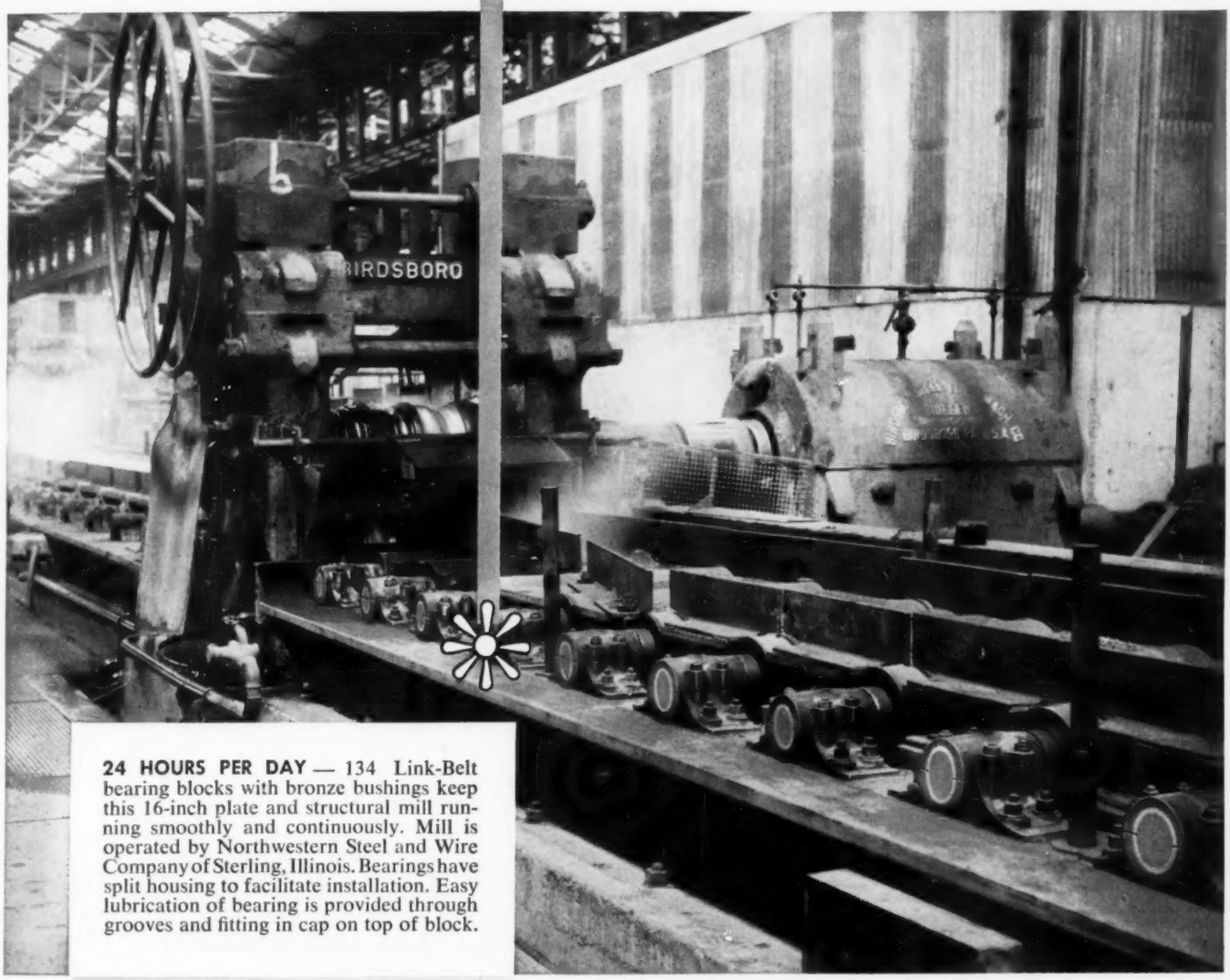

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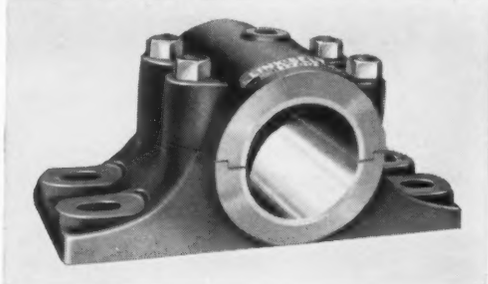

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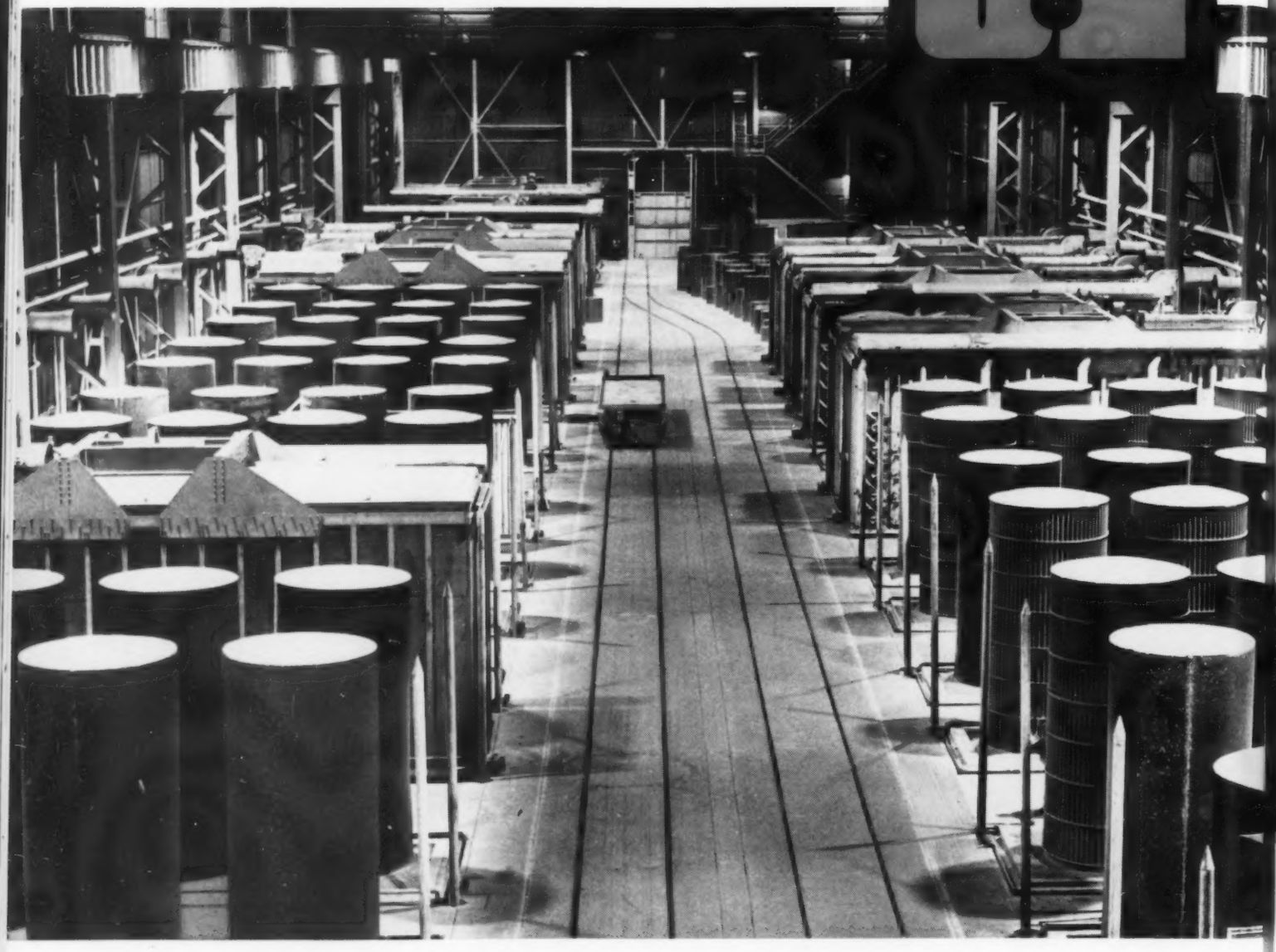

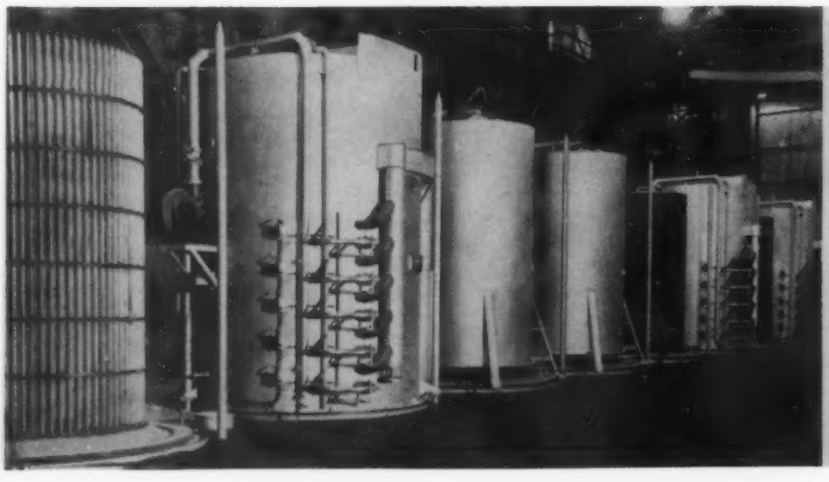

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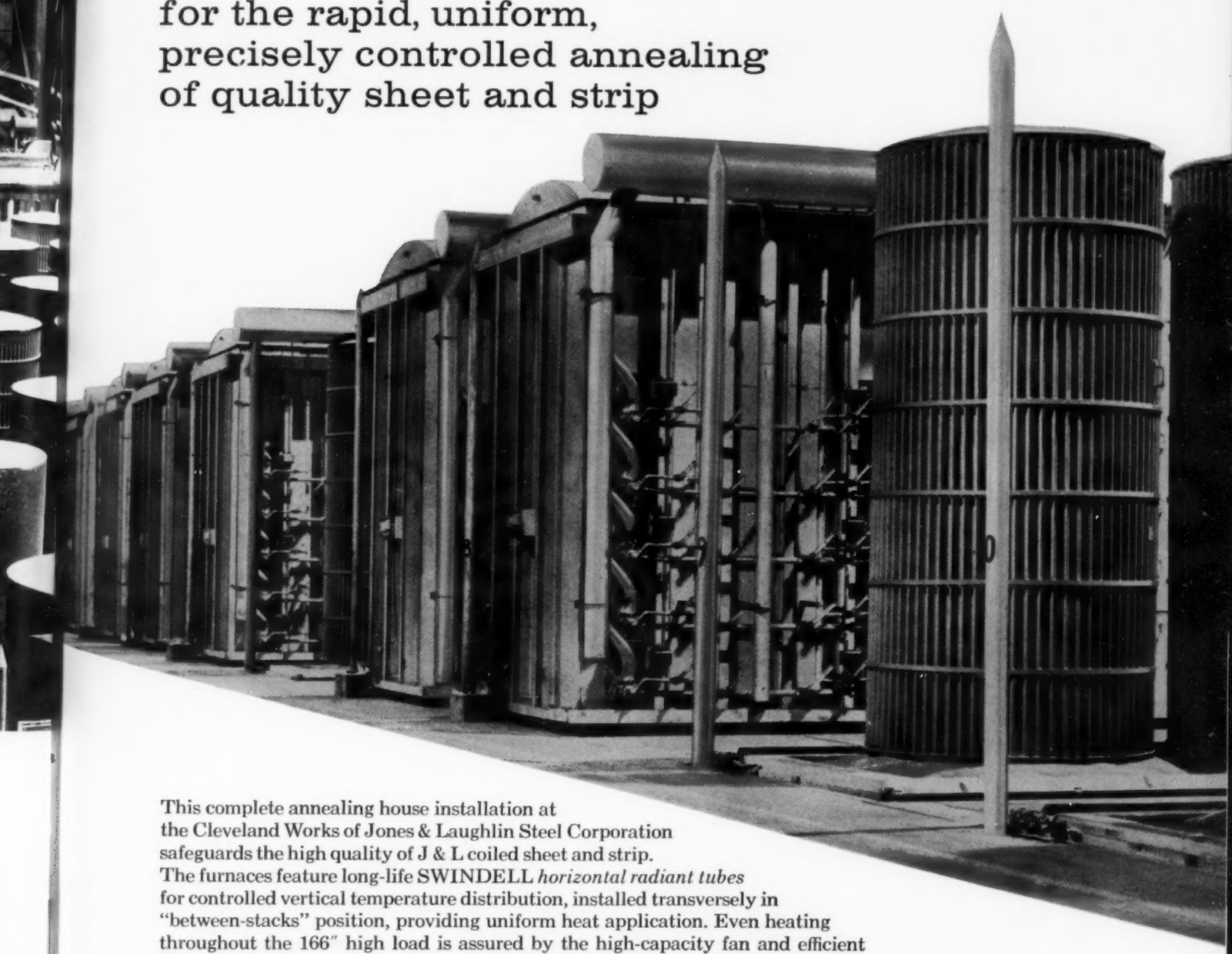

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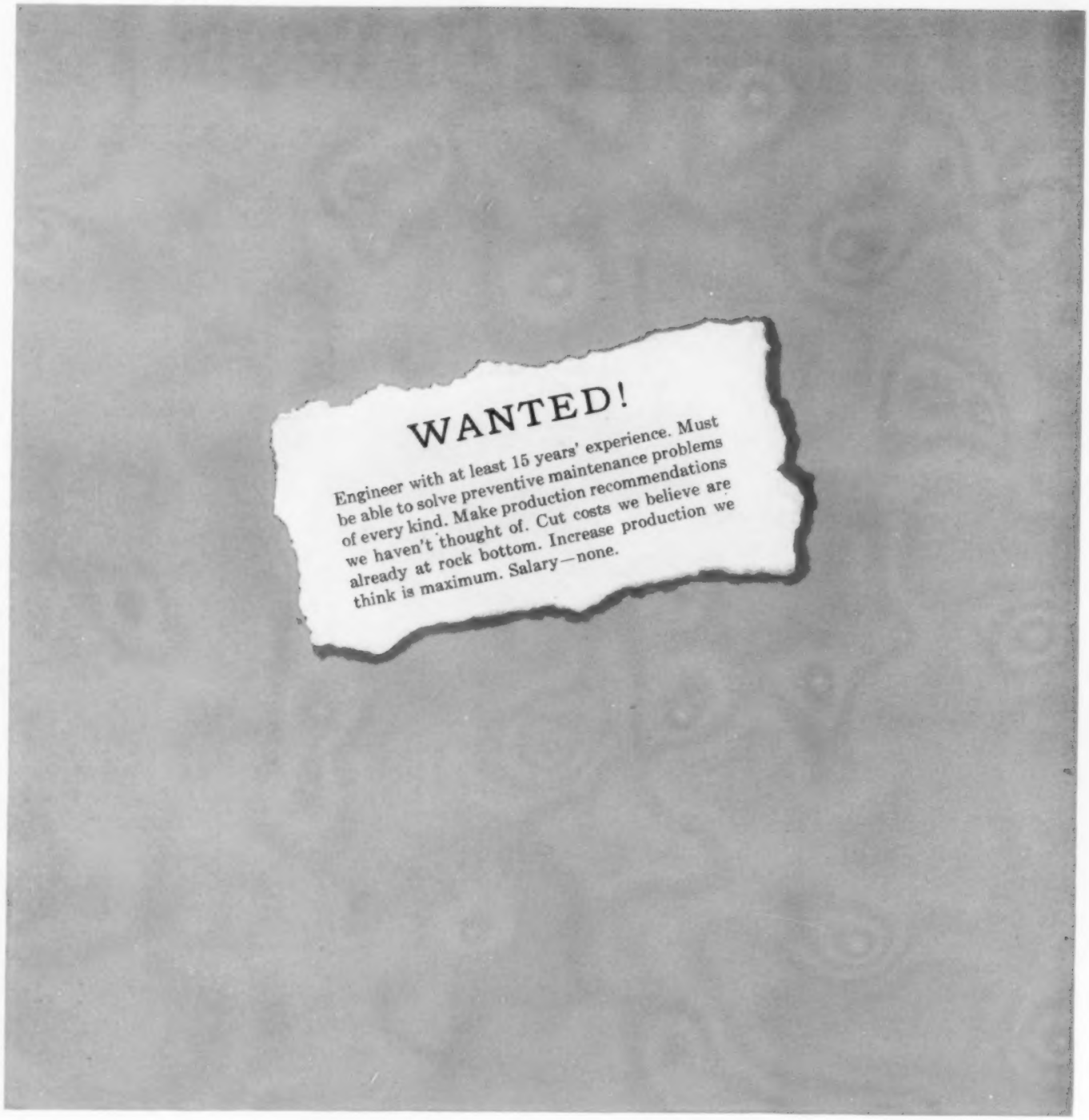
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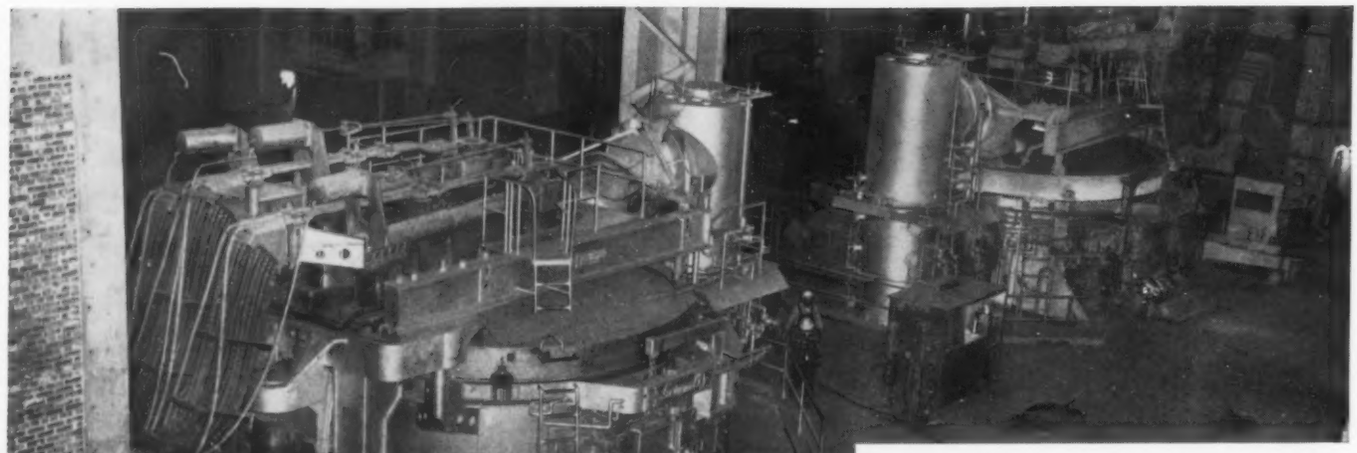

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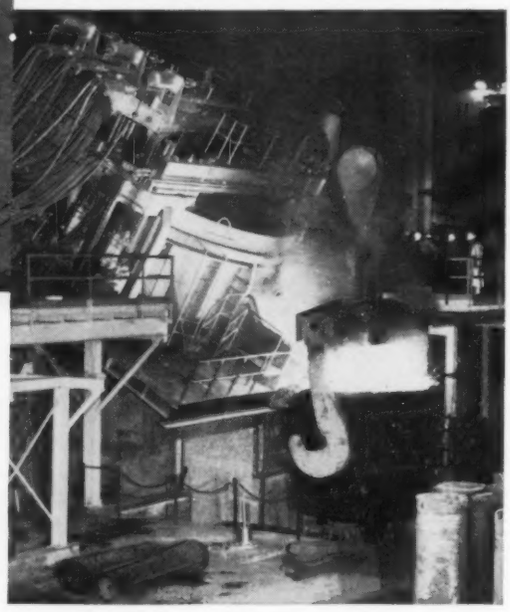

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Ingot production and slab rolling capacity are increased . . . . increased power requirements necessitated additional powerhouse facilities and distribution lines.

The Expansion Program at Sparrows Point

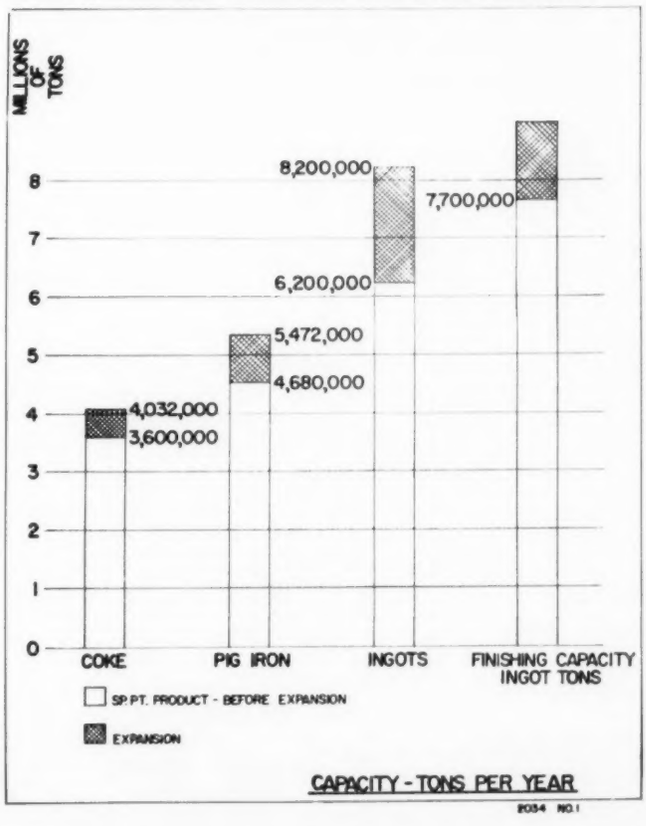
"ENGINEERING AND MECHANICAL ASPECTS"
by George C. Little,
Assistant Superintendent,
Mechanical Dept.,
Bethlehem Steel Co.
Sparrows Point, Md.

THE Sparrows Point plant was acquired by Bethlehem Steel Co. in 1916. At that time it consisted of four 200-ton per day blast furnaces, five 50-ton open hearth furnaces, four 10-ton bessemer converters and a rail mill. From this tiny beginning the Sparrows Point plant has expanded into a completely integrated steel plant with ten blast furnaces, a bessemer, 35 open hearths and sufficient mill capacity to finish an annual output of 8,200,000 tons of ingots. With this tonnage Sparrows Point has grown to be the largest steel producer in the world.

An attempt to follow the developments at this plant would be a series of steps with steel production constantly trying to keep pace with finishing capacity, and the blast furnaces trying to produce enough iron for open hearth operation, etc. This development had progressed until, in 1955, the finishing mills were so far ahead of steel production that new ingot producing units were mandatory. This paper will deal with recent developments at the plant but with emphasis on the 1956 ingot expansion program.

Figure 1 demonstrates that, at the 1955 rate of operation, Sparrows Point could produce only 6,200,000 tons of ingots while 7,700,000 were required. The finishing mills were demanding 1,500,000 tons more steel than the rated capacity of the open hearth furnaces. This demand was satisfied by shipping steel ingots to Sparrows Point from other corporation plants. To make the situation even more critical the proposed increased finishing facilities, such as the new electric weld pipe mill, the 4-high 160-in. plate mill, improvements in the sheet and tin division, etc., would further increase the demand for ingots. To satisfy this demand

Figure 1 — This bar graph shows the 1955 yearly production of the various facilities at Sparrows Point. The finishing mills required 1,500,000 tons more steel than the rated capacity of the open hearth furnaces before expansion.



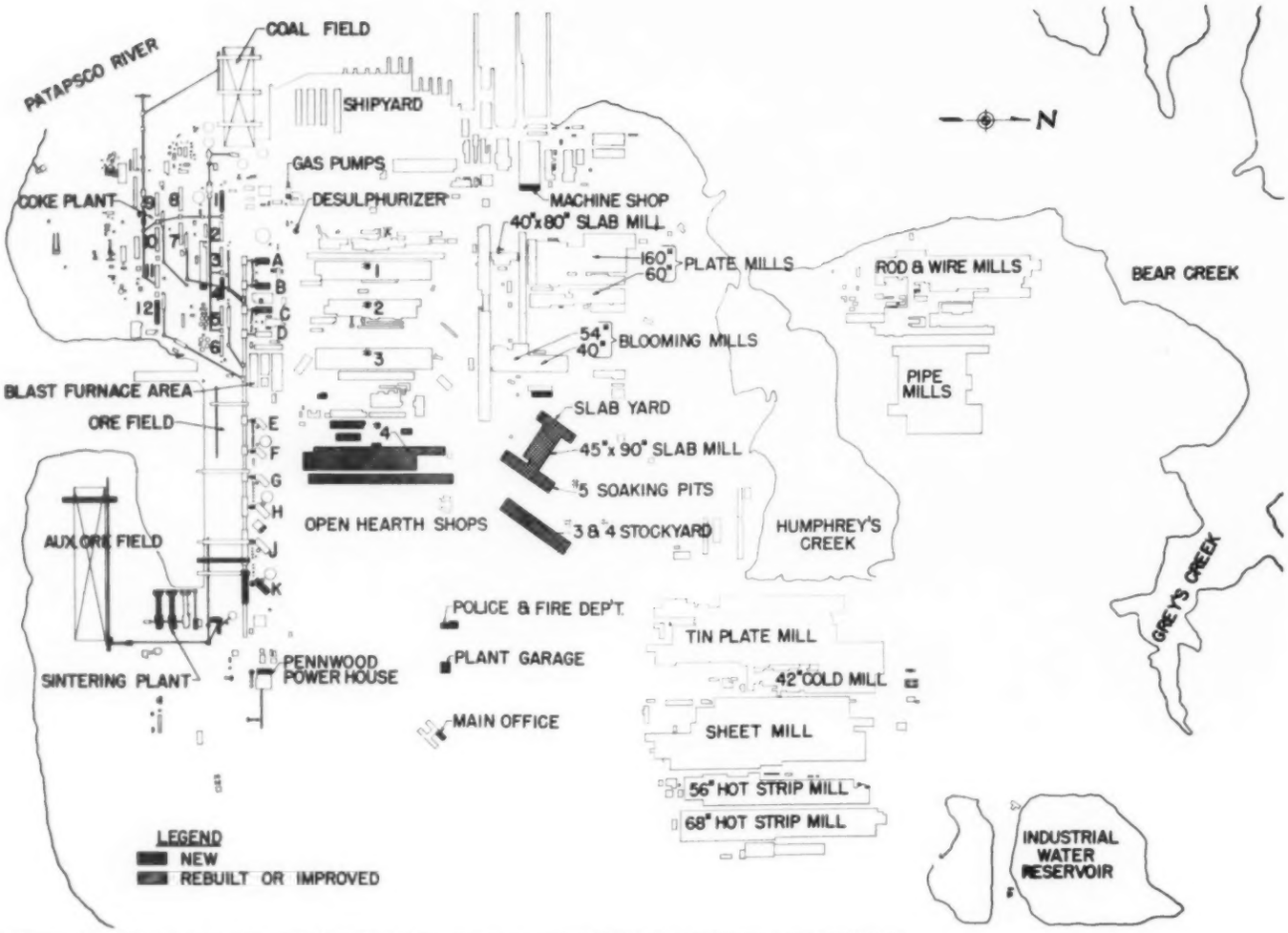


Figure 2 — This plant layout drawing shows the new and rebuilt or improved facilities.

the 1956 expansion was necessary. The description of the program will be presented in three sections: first, a general description of the new facilities, their location and auxiliaries; second, foundations including soil conditions and piling; and third, buildings and equipment.

GENERAL DESCRIPTION

The Sparrows Point plant is located, as shown in Figure 2, on the north shore of the Patapsco River and is connected to the Chesapeake Bay by a 40-ft channel. Ore and coal are delivered by water to the south side of the plant. These materials are taken directly to storage yards and then to the coke ovens and blast furnaces. Because this expansion program has brought changes to all the steel producing units, changes in the direction of material flow, will be considered.

Coke oven dept—Sparrows Point has added the new No. 12 battery; rebuilt the No. 4 battery, installed one new 20,000-cfm gas pump making a total pumping capacity of 120,000 cfm, installed one new desulphurizing unit with a capacity of 56,000 cfm, and will rebuild the No. 1 battery.

The No. 12 coke oven battery, shown in Figure 3, consists of 65 underjet ovens and is a near duplicate of the No. 11 battery. The new battery increased the plant coke capacity by 10 per cent. The foundations for this battery presented a problem, which is discussed in another section.

Blast furnace dept—The new "K" blast furnace with a 28 ft-9 in. diam hearth is the tenth in line. The "A" and "B" blast furnaces have been enlarged from 24 ft-6 in. to 25 ft-6 in. hearth diameter.

The "K" furnace, shown in Figure 4, was blown in March 27, 1957. This is a near duplicate of the "H" & "J" furnaces with the principal dimensions being 28 ft-

Figure 3 — The new No. 12 coke oven battery increased the plant coke capacity by 10 per cent.

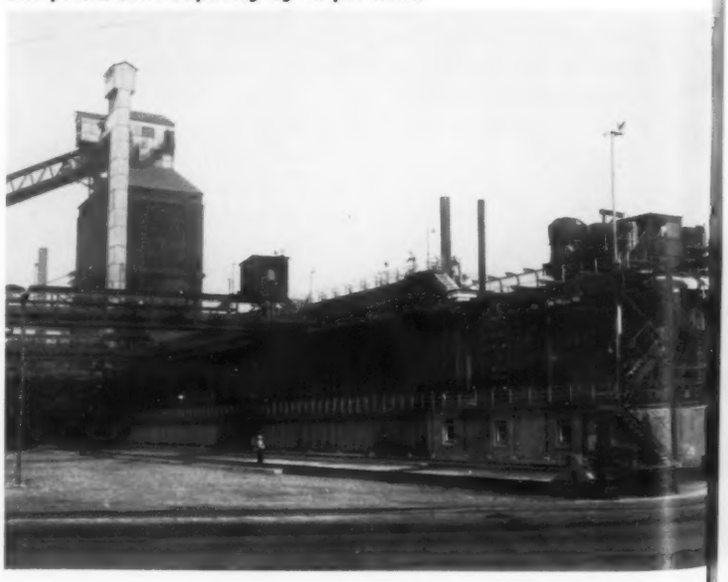


Figure 4 — The new "K" blast furnace is a near duplicate of the "H" and "J" furnaces.

9 in. hearth diameter and 105 ft from tap hole to the top of the furnace hopper. The total volume is 58,274 cu ft. The installation includes a 100,000-cfm 30-psi turboblower; four 28-ft diam, 133-ft high stoves with a total heating surface of 220,427 sq ft each; and a gas cleaning system with a primary washer and precipitator.

The "C" blast furnace has been rebuilt and enlarged from 25 ft-6 in. to 28 ft-0 in. hearth diameter. A new 100,000-cfm turboblower has been installed for the "C" furnace. Four 6-ft wide, 110-ft long sintering strands have been added making a total of six with a capacity of 340,000 tons per month. The new 1,500,000-ton ore field, with its conveyor system and new ore screening station, went into operation in 1956.

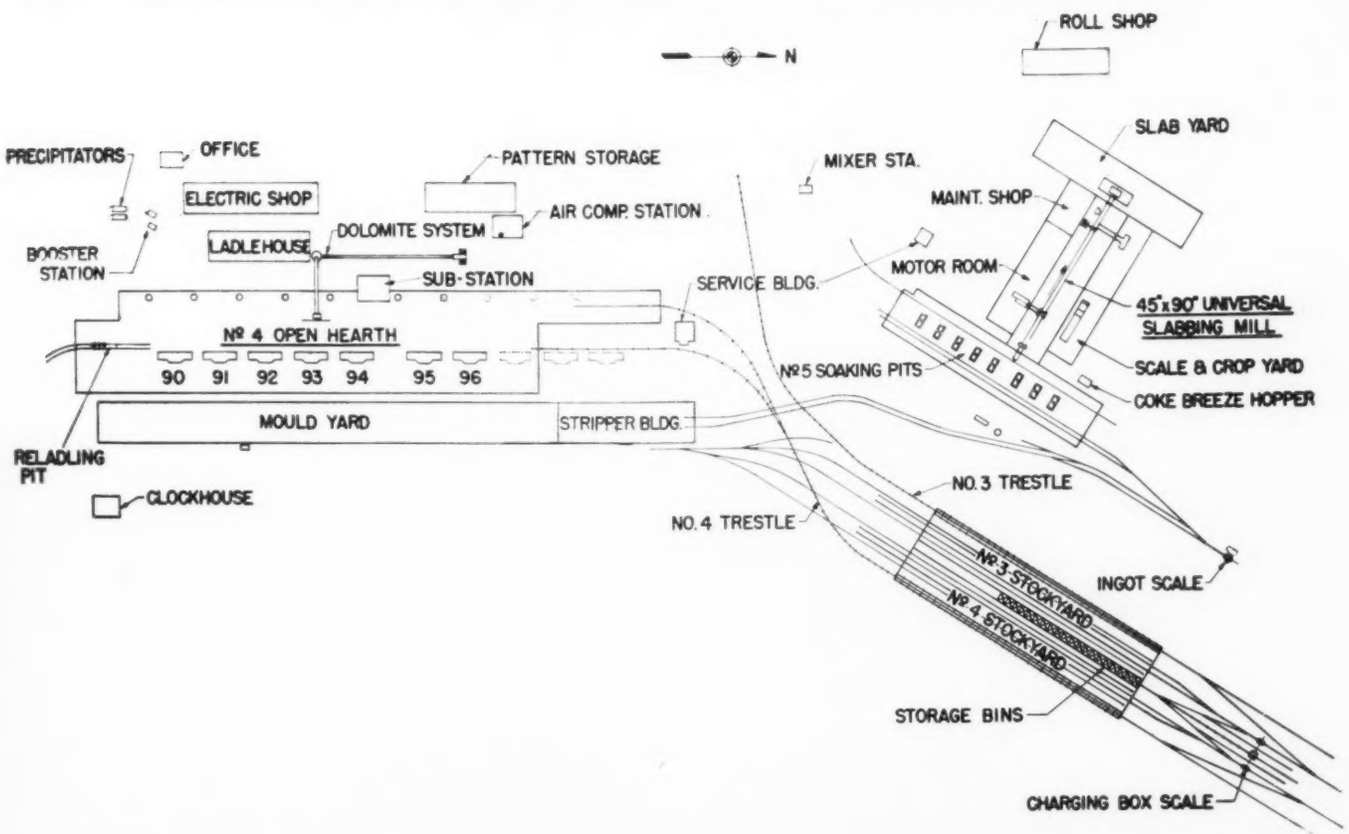
Open hearth dept—The new No. 4 open hearth, shown in Figure 5, with an annual capacity of 2,000,000 tons, is the major addition at this time. It is equipped with a stripper, a mold preparation building, ladle house, dolomite system and stockyards for the No. 3 and No. 4 open hearths. The No. 4 open hearth is placed parallel to the three existing shops with the required width for economical and safe operations and its length a maximum determined by the existing plant.

The mold yard and stripper building is located east of the open hearth. The stripper section is at the north end and is equipped with two 400-ton stripping cranes. The mold preparation area is directly south of the stripper and is arranged from north to south. It has a cooling section and a mold preparation section equipped with two cooling tanks and mold spray tanks. The extreme south area is for storage of prepared molds and future hot topping operations.

The No. 4 open hearth and slab mill, with their auxiliaries, presented many interesting engineering problems. Three factors that had to be satisfied were:

1. The most economical use had to be made of available space.
2. Provision had to be made for future expansion of the units.

Figure 5 — The major addition is the No. 4 open hearth shop with an annual capacity of 2,000,000 tons.



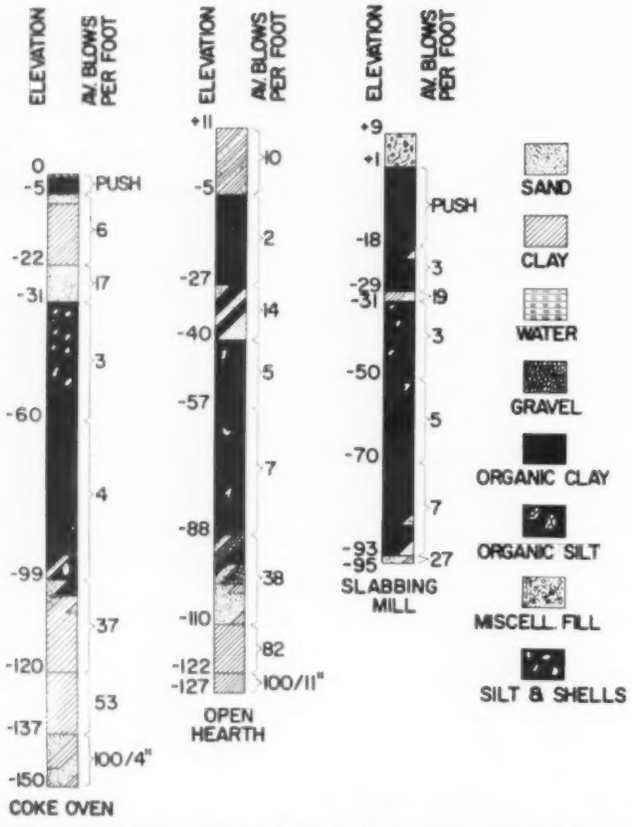


Figure 6 — These are typical borings that were made for the coke oven, open hearth and slab mill, structures.

3. Flexibility and economy of railroad tracks were required.

Stock yard—The new stock yard is built parallel to an existing classification yard and is equipped to serve the No. 3 and No. 4 open hearth shops. The stock bins are designed to receive ore, stone and calcined lime from the bottom dump hopper cars and discharge it through the bins into the open hearth charging boxes. A four-track open type scrap yard is located on both sides of the stock bins. The west yard serves the No. 3 open hearth shop and the east yard the No. 4 shop. Prepared scrap is delivered on the two outside tracks and transferred to the charging boxes by overhead magnet cranes. There are five cranes in the two yards. Four 60-cu ft charging boxes are placed on two axle cars carrying an average of 30,000 lb of scrap per car. The scrap, ore, stone and lime cars are weighed, while in motion, on electronic scales when leaving the yard. They are then shifted to the open hearth porch and later pulled on to the open hearth charging floor by the charging machines.

Slab mill—The primary considerations in locating the 45 x 90-in. slab mill and soaking pits were capacity for expansion and the railroad connections between the new pits and the existing soaking pit building. The final location of the mill and pits is such that ingots can be transferred from the old pits to the new mill and from the new pits to the old mills. Furthermore, new soaking pits can be added when required.

Blooming mill—The blooming mill department has been expanded by adding a new 45 x 90-in. slab mill with the No. 5 row of soaking pits, a slab yard, a gas mixing station and a gas booster station.

Finishing mills—A new 4-high mill has been added to 160-in. plate mill increasing its capacity to 70,000 tons per month. The old lapweld pipe mill has been replaced with a new electric weld pipe mill having a capacity of 20,000 tons per month and capable of producing pipe in sizes from 4½ to 16 in. outside diameter and up to 60-ft lengths.

The changes in the sheet and tin mill division, which affect quality or quantity of production, consist of improvements in the reheating furnaces, more cold reducing mills, new continuous annealing facilities, and many others.

Miscellaneous—Other added facilities are a new boiler and a 33,000-kw generator at the Pennwood power house, an addition to the electric repair shop, a pattern storage building, an air compressor station, an extension to No. 2 machine shop, a new home for the fire department and police department, a new plant garage, and an addition to the main office building.

As previously stated, this paper is intended to deal primarily with the ingot expansion program, which concerns the coke oven, blast furnace, open hearth and slab mill departments.

SOIL CONDITIONS

After the principal structures had been located on a plot plan, and an estimate of building and equipment loads had been established; the soil structure was investigated by taking about 130 borings. It was determined that much of our new plant expansion had to be built in areas that had been open water a few years ago. The soaking pit area was filled with river dredgings in the early twenties, and the No. 12 battery had to be built over an open salt water intake.

Soil borings revealed that most of the structures had to be carried on steel piles. Three sizes of piles were used. The 14-in. at 73 lb were loaded to 150 tons; the 12-in. at 53 lb carry 105 tons; and the 10-in. at 42 lb are handling 83 tons each. These were shipped in 50 to 70-ft lengths to Sparrows Point where two or three lengths were welded together. Some were driven in the 70-ft length and the second and third pieces added, but some were welded in advance and driven in the 140-ft length. Figure 6 is a bar graph for pilings that were typical of the coke ovens, open hearth and slab mill.

In the open hearth department alone 5548 piles were used. These were driven to minus 125 ft and deeper. The steam hammer used developed 15,000 ft-lb per blow at 120 blows per min with 110-psi steam pressure. The number of blows per foot for final penetration was 144, 120, and 108 for the 14, 12 and 10-in. piles respectively. Figure 7 shows the hammers at work.

As shown in Figure 8, soil water conditions in the soaking pit area were so bad that french drains and sump pumps were used to drain the area.

The shear strength of the soil was so low that wooden mats were used to support excavation equipment. Figure 9 shows some of these mats.

A four to seven-foot thick slag mat, shown in Figure 10, was placed on the floor and sides of the excavation to prevent slides and provide a solid area for the pile drivers. The 140-ft piles used in this area were carried down about 30 ft by the weight of the hammer. Very little resistance was offered until final takeup.

Some of the piles for the No. 12 battery were driven in water, and the area filled in later. Figure 11 depicts this operation.

BUILDINGS AND EQUIPMENT

The arrangement of the open hearth building, shown in Figure 12, is conventional with three aisles. Because all the equipment used in this shop is the largest ever built for this service, the entire building is wider. Detail dimensions will be given later, but there is one feature which should be noted here. As previously stated, the safety of personnel was considered in all phases of construction. For this reason the charging aisle was made 93 ft wide to allow walking space on both sides of the hot metal transfer car. The material handling equipment located in this aisle consists of three 200-ton hot metal cranes and three 15-ton charging machines. The pouring aisle is equipped with three 500-ton cranes and two pouring platforms. The north platform is 640 ft long, and the south platform is 440 ft long. The ladle lining pit and ladle drying stand are located in this area. The physical dimensions of the open hearth buildings with their cranes are shown in Table I.

The hot metal transfer station is located at the south end of the charging aisle at ground level. It consists of one double pit served by two railroad tracks, one on each side. Molten iron is delivered here in 125-ton mixer type cars from which the iron is dumped into a 150-ton hot metal transfer ladle. This ladle is held in position by the charging floor crane while the hot metal is transferred. Four mixer cars can be spotted at the pit at one time with tail track enough for one additional car on each side. This makes it possible to have 375 tons of hot metal on each side of the pit. The mixer cars are moved by a car puller. The northernmost pit is located in such a position that it may be reached by the No. 2 floor crane. Figure 13 is a sectional view through

Figure 7 — Piles, some of which were welded together to obtain 150-ft lengths were driven for many of the principal structures.

Figure 9 — To keep them from sinking into the soft ground the excavation machines were placed on wooden mats.

Figure 8 — The condition of the soaking pit area was such that drains had to be dug and sump pumps had to be used.

Figure 10 — To provide a solid area for the pile drivers and to prevent slides, a four to seven-foot slag mat was placed on the floor and sides of the excavation.

Figure 11 — Some of the piles were driven in water after which the area was filled.

TABLE I
Open Hearth Buildings Dimensions

	Length, ft-in.	Width, ft-in.	Cranes	
			No.	Capacity, tons
Lean-to	1110-0	73-0	...	.....
Charging aisle	1230-0	93-0	3	200/40
			3	15-charger
Pouring aisle	1230-0	88-0	3	500/75/25
Stripper	360-0	100-10	1	400/10
			1	400 with stool knocker
Mold yard	1230-0	100-10	1	50/25
			1	25/15
Ladle house	270-0	77-0	1	75/40/10
No. 3 stock yard	704-0	80-0	3	15-Magnet
No. 4 stock yard	704-0	80-0	2	15-Magnet

the open hearth building at the hot metal transfer station.

The tilting control for the hot metal ladles is located in a combination control and scale house at the south end of the charging aisle.

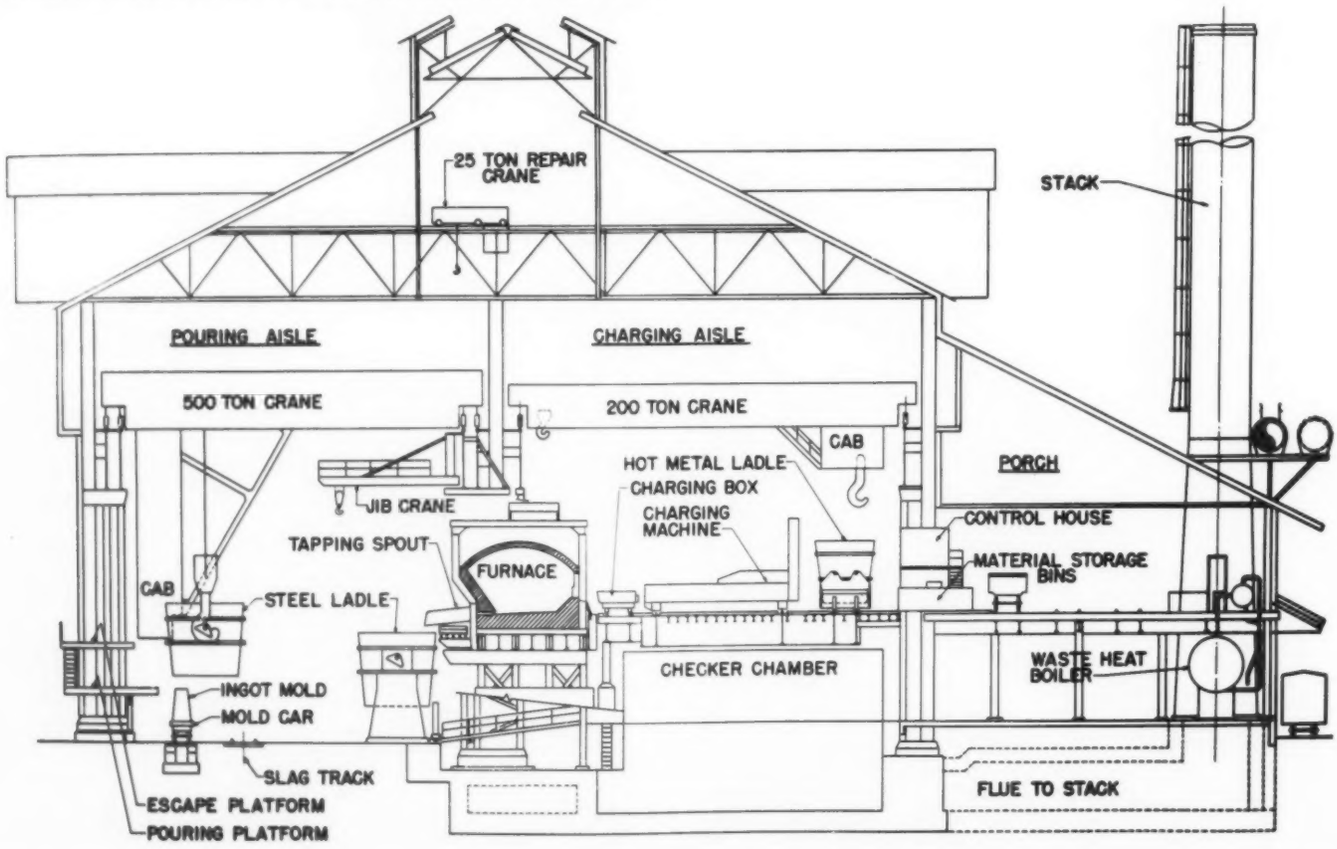
After loading, the 150-ton ladle may be placed on a hot metal transfer car where it is weighed and taken on a track, which extends the length of the shop, to the charging floor.

Dolomite is brought to the open hearth by a conveyor belt system that consists of two track hoppers, a 400-ton overhead storage bin outside the open hearth, and a 100-ton bin inside the building. This bin is equipped with two chutes and two vibrating feeders which deliver the material to the dolomite machines or boxes on the charging floor. The vibrating feeders have dual control so that a floor craneman or a furnace operator may regulate the filling of the dolomite machines. The system is shown in Figure 14.

The entire system of conveyors and bins is equipped with electrical interlocking devices to prevent overloading of bins and to protect personnel during repair and maintenance. Also, all bins are equipped with level controls and indicators. The system of bins and hoppers is designed so that at least a 24-hr supply is available when the bins are full.

The seven open hearth furnaces, one of which is shown

Figure 12 — Sectional view of the open hearth building design is conventional but wider than other open hearth buildings to accommodate some of the largest equipment in the world.



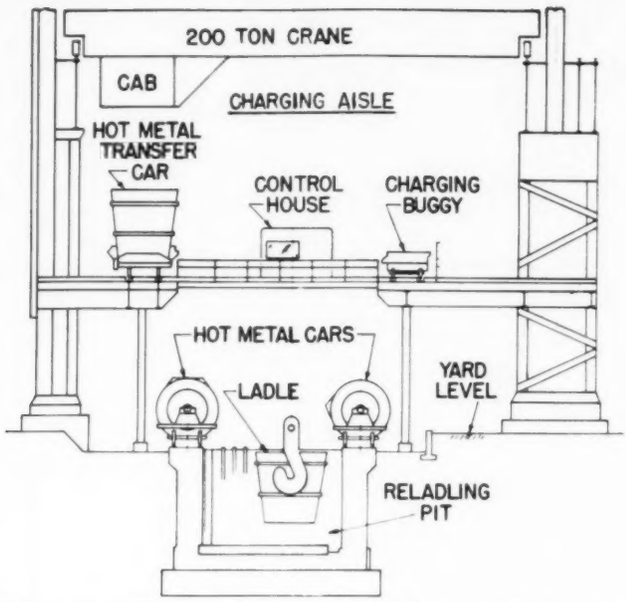


Figure 13 — This sectional drawing shows the hot metal transfer station.

in Figure 15, are of modern design. They are, however, the largest furnaces in the corporation, which tap into a single ladle. Combustion air is delivered to the furnace by a forced-draft fan capable of delivering 50,000 cfm of air at a temperature of 100 F against a static pressure of 6-in. water column. This air travels through a two-pass regenerator which has 54,000 sq ft of heating surface, through the slag pocket, and into the furnace through a double uptake. One burner is used at each end of the furnace. The water cooled burner is located in a dog house in the middle block and is designed to burn oil and gas or tar and gas. It has a maximum firing rate that is equivalent to 1500 gal of Bunker C oil per hr.

The furnace is 104 ft-3¾ in. long and 28 ft-10½ in. wide, outside of buckstays, and is equipped with seven 5 ft-8 in. x 5 ft-8 in. doors.

On leaving the furnace the hot gasses pass through the slag pocket, which is 21 ft-11½ in. wide and 19 ft-10½ in. long inside of brick, and into the two-pass regenerator.

Each pass is divided into two chambers by a longitudinal wall extending from the floor of the regenerator chamber to the roof. Each chamber of the first pass of the regenerator is 13 ft-9¼-in. wide by 22 ft-9 in. long inside of brick. Each chamber of the second pass is 13 ft-9¼ in. wide by 15 ft-¼ in. long. The height of the regenerator from floor to roof is 30 ft-1⅝ in. inside of brick.

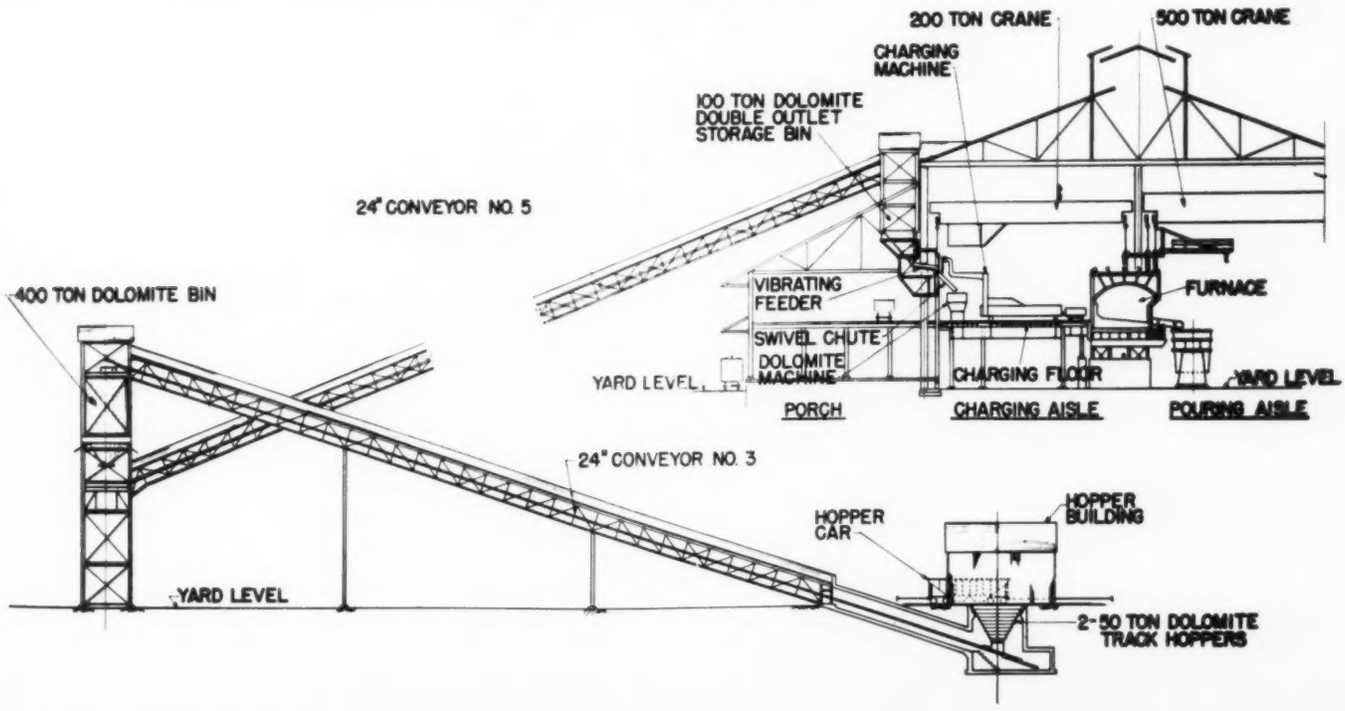
The checkers in the first pass are constructed of 9 x 4½ x 3-in. high duty clay brick laid to form 9 x 9-in. openings 15 ft-9 in. high. The second pass is built with 13½ x 6 x 2½-in. high duty clay brick laid to form 5½ x 5½-in. openings 15 ft-6 in. high.

Each furnace is equipped with one single pass, horizontal fire tube waste heat boiler with a superheater. The design pressure of this boiler is 350 psi, and the steam temperature is 675 F. The induced draft fan is rated at 300,000 lb of waste gas per hr at a temperature of 560 F and a pressure of 12-in. water column. The flues are of adequate size for the maximum firing rate and are equipped with steam soot blowers.

The stack is 240 ft high and has approximately a 12 ft diam inside of brick.

Furnace design—The furnace, shown in Figure 16, is of conventional design with sloping back wall, water-cooled buckstays, and water-cooled doors and door frames. The plate steel pan is carried on 15-in. beams that rest on seven longitudinal girders. These are carried on two structural steel supports. This pan is lined with 1½-in. of chrome ore, 18 in. of magnesite brick laid in the inverted arch design and 18 in. of rammed magnesite. Basic brick port ends are used on

Figure 14 — The dolomite belt conveyor system is designed so that at least a 24-hr supply is available when the bins are full.



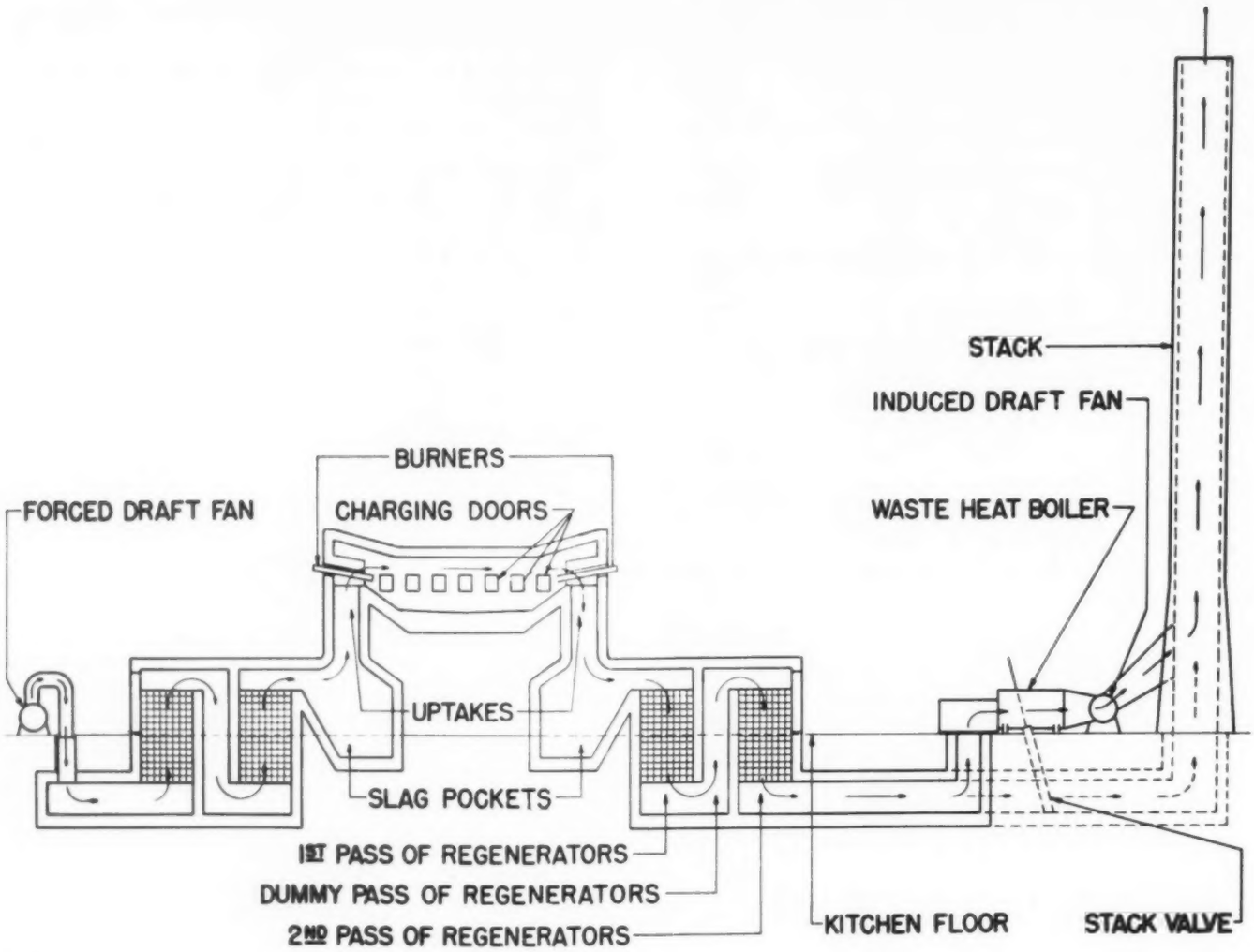
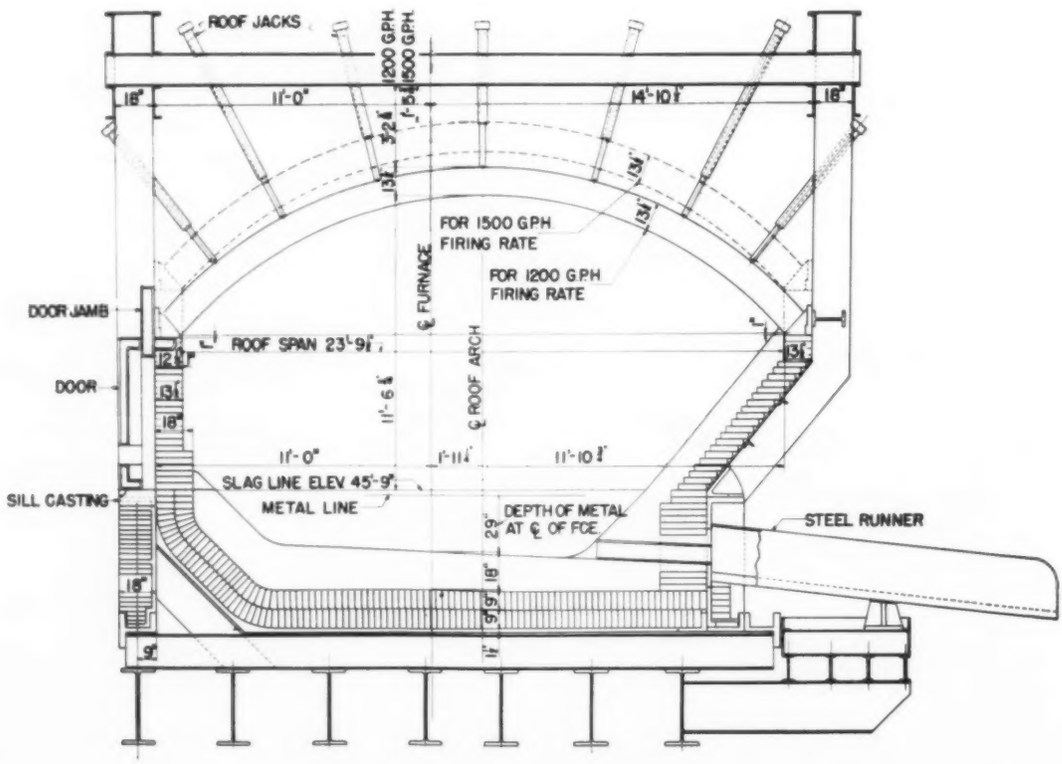


Figure 15 — The new open hearth shop has seven furnaces alike.

Figure 16 — New open hearth furnace is rated 350 tons.



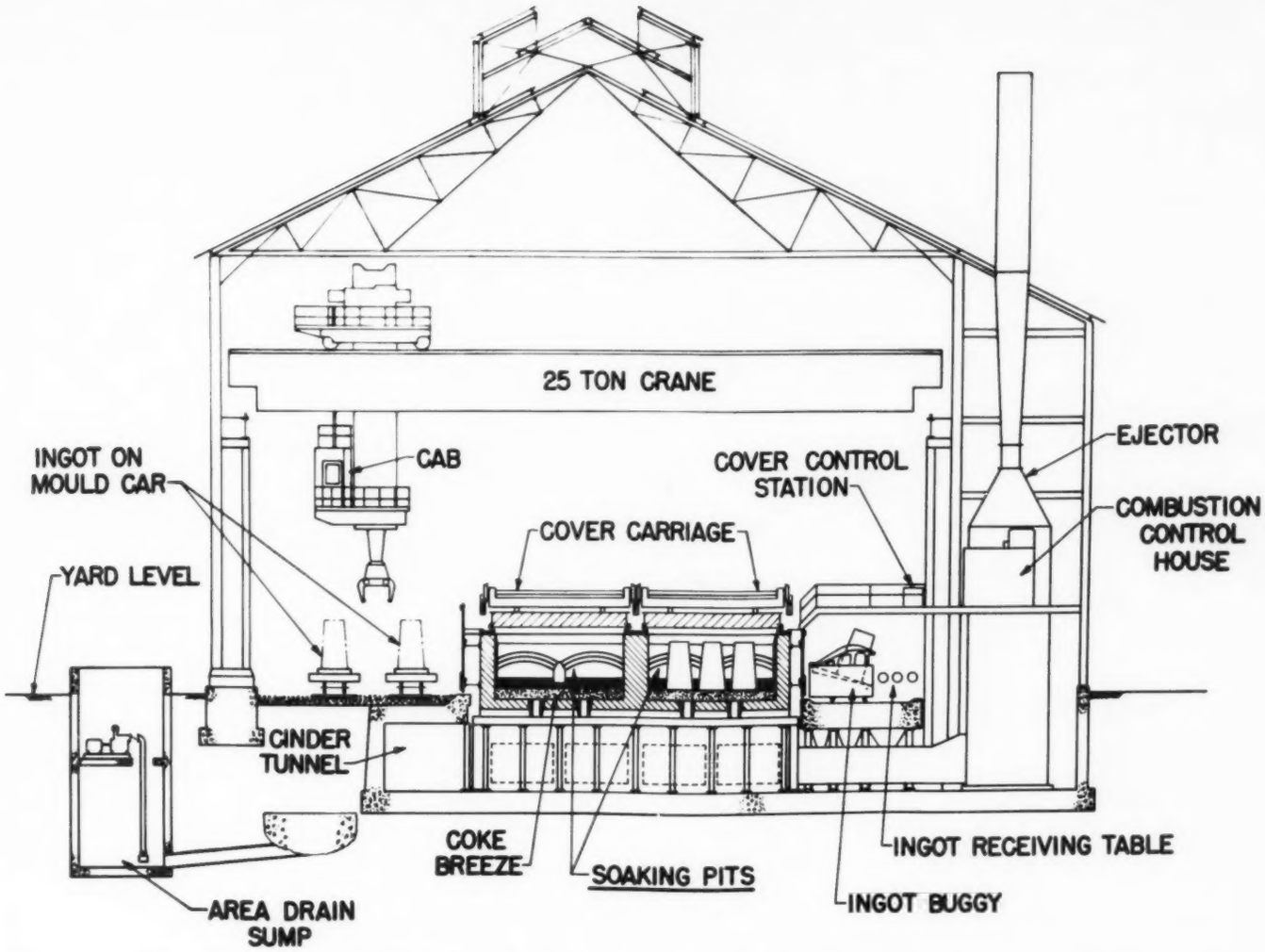


Figure 17 — Section of one of the eight new rows of slab mill soaking pits shows equipment arrangements.

five of the seven furnaces. No. 90 and 93 are built with silica brick. The furnace roof construction is 13½-in. super duty silica brick with bonded construction. The present roof is located for a firing rate of 1200 gphr with the possibility of being relocated for 1500 gphr without making major changes in the structural steel. The rated capacity is 350 tons per heat with a metal depth of 29 in. at the centerline of the furnace. The hearth area, inside of brick at the door sill elevation, is 1271 sq ft. Provisions have been made for front flushing through the No. 4 door. This slag is dropped onto the floor at pit elevation and, after cooling, is loaded into trucks for disposal.

Steel ladles—The steel ladles are designed to carry 385 tons of steel. Their physical dimensions are 16 ft-4⅝ in. inside diameter at the top, 13 ft-6$^{13}/_{16}$ in. inside diameter at the bottom, and 15 ft-2½ in. high. They are of welded and riveted construction and are made of three welded sections which were riveted together at Sparrows Point. The bottom of the ladles is of flat reinforced design, which is equipped with a link-and-pin dumping mechanism. The outside link can be engaged with the auxiliary block hook without having a workman go under the ladle. These ladles are equipped with two nozzles and stopper rods.

Slag handling—The tap slag drains from the top of the ladle into a 375-cu ft slag bowl, which is placed on a stand in such a position that any excess slag will cascade into a second bowl of similar size. These bowls are later placed in a twin-pot air-dump car and taken to the slag recovery pit where the slag is crushed and sent to the blast furnaces.

500-ton pit crane—The steel ladles are handled by the largest open hearth pit crane ever built. It, as previously stated, is designed to handle 500 tons on its main hooks. It is also equipped with two auxiliary hooks, one 75 tons and the other 25 tons. The total weight of this crane with a loaded ladle is about 1400 tons. This unusually heavy moving load has made necessary a new design of end trucks and runway girders. The crane is carried on 24 30-in. diam wheels on each end. These are mounted on 12 double-wheel axles and operate on two 175-lb rails, which are carried on two runway girders. Each girder is about 12 ft deep and 120 ft long. The physical dimensions and weight of these girders are very near the one-piece shipping size limit of a structural member.

Soaking pits—In the slab mill section eight rows, one of which is shown in Figure 17, of soaking pits are provided. They are of the island-type arrangement with steel delivery tracks on one side and the side dump ingot buggy on the other.

Each row consists of two holes 16 ft by 20 ft and 10 ft-5 in. deep. This allows for 21 in. of coke breeze in the bottom.

These pits, shown in Figure 18, are the side-fired

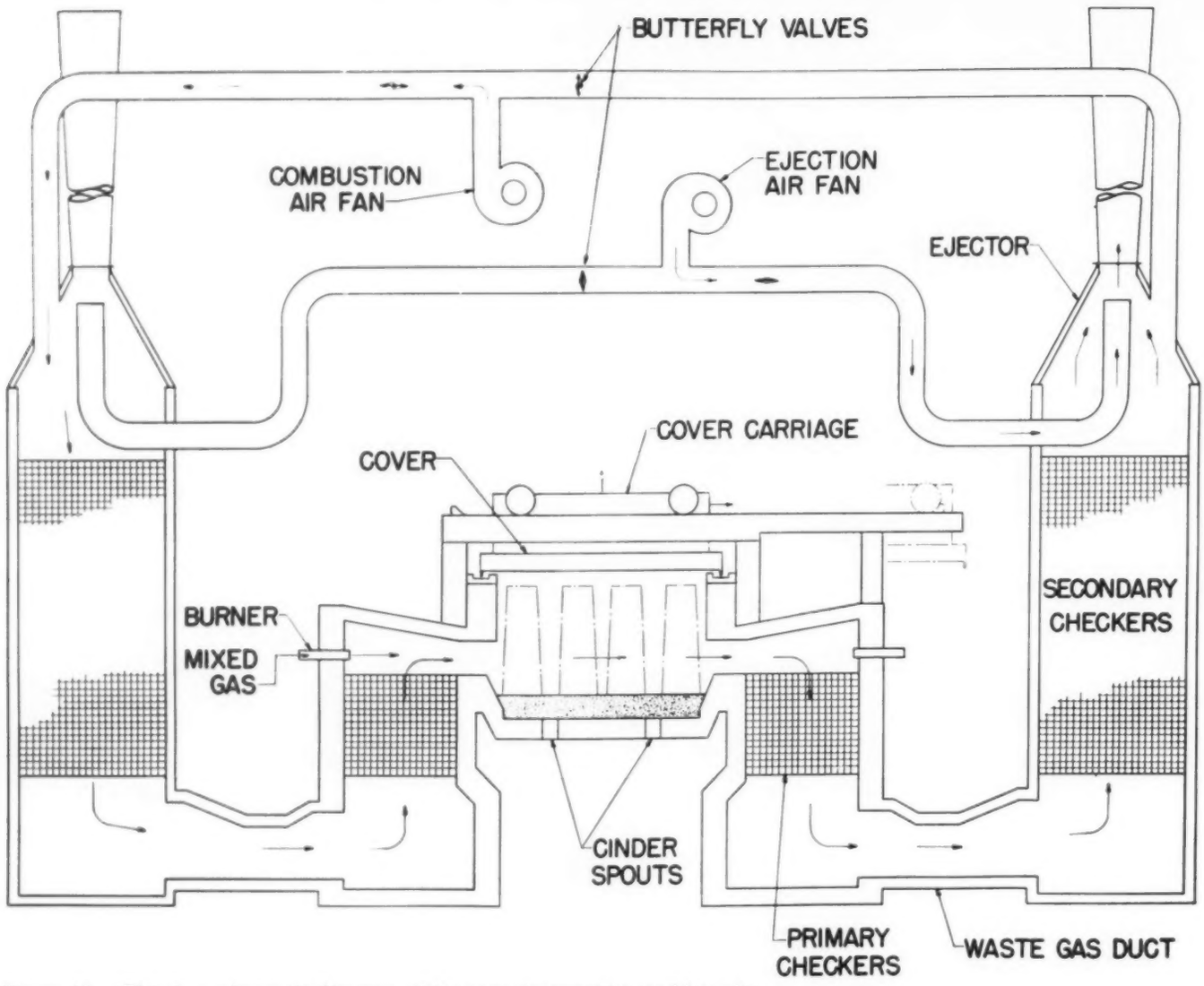
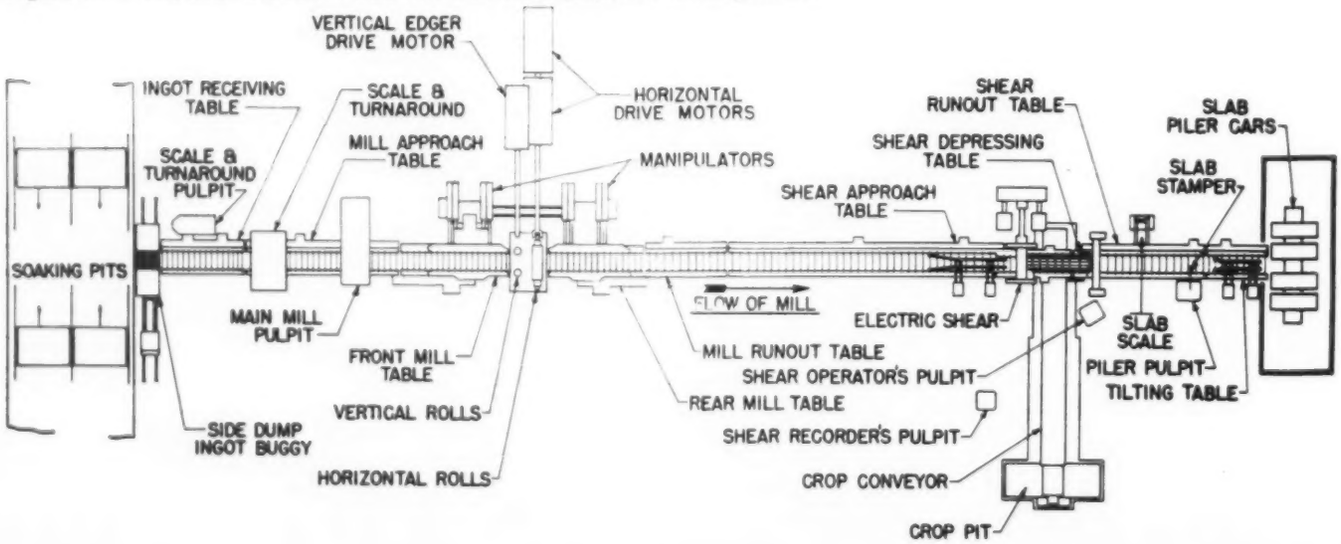


Figure 18 — This is a schematic diagram of the new regenerative soaking pits.

regenerator type with the first section of the regenerator beside the pit and the second section in the lean-to of the soaking pit building. The fuel used is mixed blast furnace and coke oven gas with a heating value of 106 Btu. The pits have an on-off temperature control with a radiation tube in the center of the pit cover for sensing temperatures. Steel is rolled at a temperature of 2450 F.

Slab mill—The new 45 x 90-in. slab mill, shown in Figures 19 and 20 is similar to several others built recently, but its arrangement is different. Steel is delivered to the receiving table by a side-dump ingot

Figure 19 — The new 45 x 90-in. slab mill has this equipment arrangement.



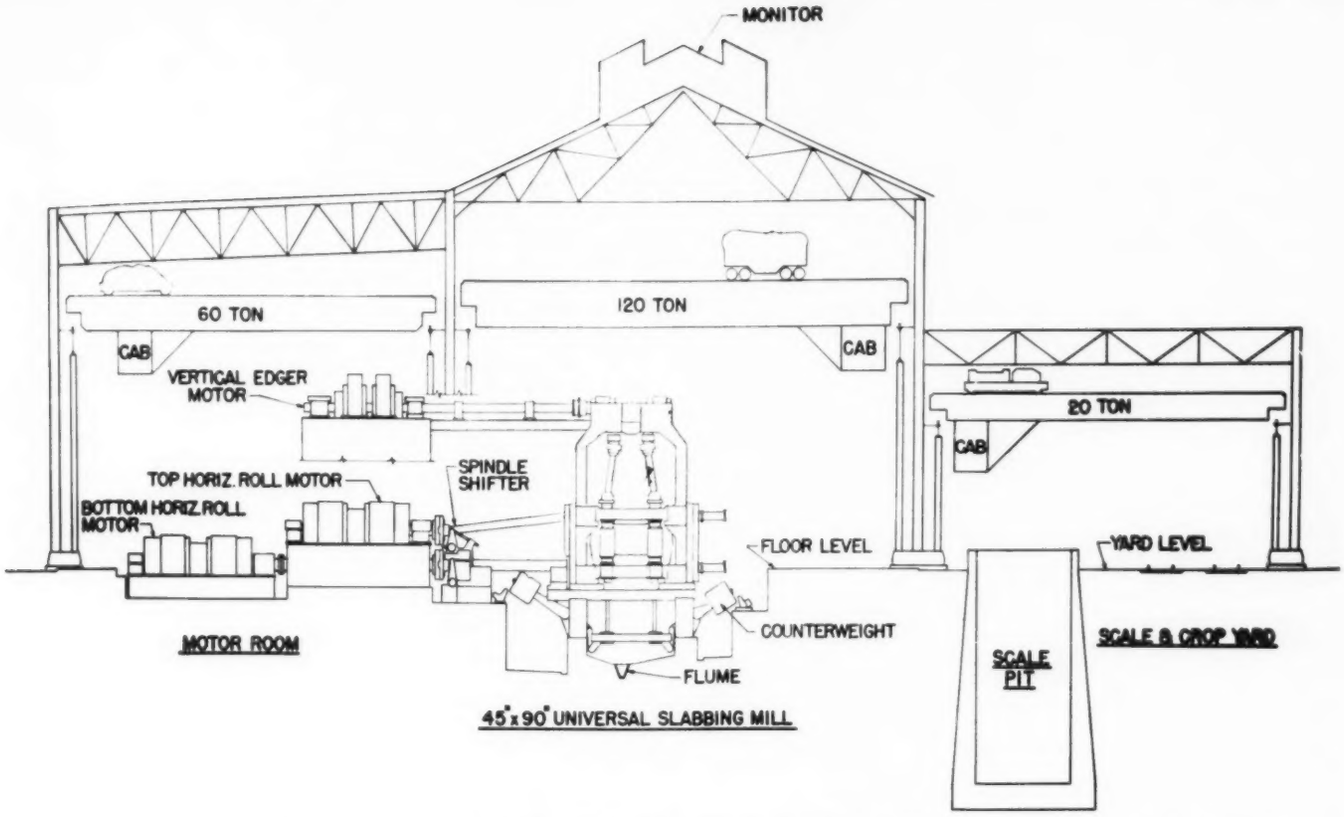


Figure 20 — The new 45 x 90-in. slab mill has a top-forward arrangement for its double-armature main drive motors.

buggy. From here, it passes over a scale and ingot turnaround. Then it goes to the vertical rolls and manipulator, which are located between the operator's pulpit and horizontal mill. After leaving the mill, the slab is sheared on a 2000-hp electric shear and piled on one of the two piler cars in the slab yard.

The crop conveyor delivers crop ends to a two section cooling pit. From here they are picked up by the magnet of an overhead crane and loaded into cars.

The scale pit is located under this crane runway, and the crane that handles the crop ends also loads scale from this pit.

The main mill is powered by two 750-v, 6000-hp, 40/80-rpm, d-c double armature motors arranged with the top-roll motor close to the mill and the bottom-roll motor away from the mill and connected to a spindle shaft extension. This top-forward arrangement permits using the overhead crane to remove parts of the lower motor without removing the spindle drive shaft of the top motor. That has to be done with the bottom-forward arrangement.

The top roll is provided with a counterweight type balancing system. The maximum distance between the centerlines of the rolls is 10 ft-3⅞ in. giving a maximum opening of 66 in.

The edging mill is driven by one 4000-hp 750-v d-c double-armature motor running at 60/150 rpm.

SUMMARY

The extent of this ingot expansion program can be summarized by reviewing the amount of material used. This job required 59,000 tons of piling, 79,000 tons of structural steel, 21 miles of double rail track, 122,000 cu yd of concrete, 15,000 tons of reinforcing rods, 70 miles of pipe, and 22,300,000 9-in. equivalent brick.

Engineering was started December 1, 1955, and our first heat of steel was tapped on October 2, 1957, just one year and eleven months after planning was started. The first slab was rolled November 12.

"ELECTRICAL ASPECTS"

by James M. Tillman,
General Foreman, Power House,
Electrical Dept.,
Bethlehem Steel Co.,
Sparrows Point, Md.

DO you think your light bills are high? If so, you can console yourself if you consider the amount of power consumed by Bethlehem Steel Co. Sparrows Point plant. The average home uses about 200 kwhr per month. The world's largest steel mill in October, 1957, for instance, used 140,000,000 kwhr or enough power to supply approximately 700,000 homes. This high-voltage power, of course, is obtained at a somewhat reduced rate.

When a steel plant expands and employs, at its peak, over 29,000 people, the resulting changes in the electrical power system of that plant are bound to be substantial. As an outline the present power system consists of:

1. The local utility service of 25-cycle power consisting of two 26,400-v circuits with a total capacity of 28,000 kva.

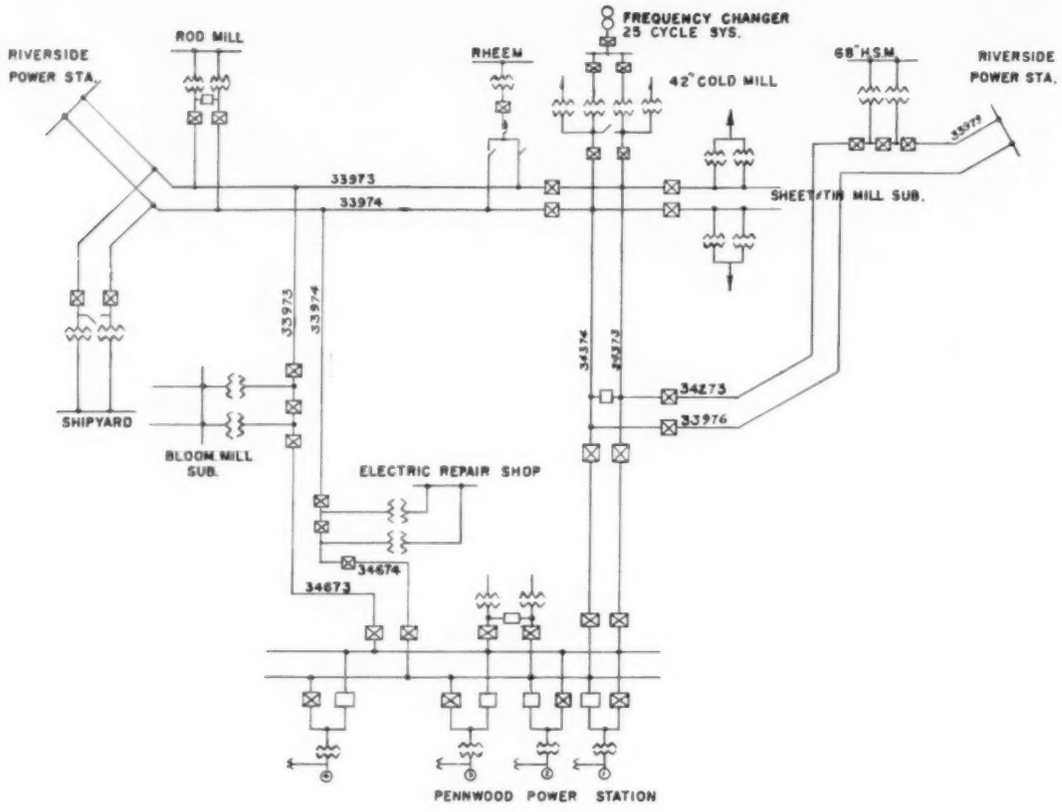


Figure 1 — The one-line schematic diagram of the 24.5-kv, 60-cycle plant primary system shows how the existing power supply was augmented by installation of additional lines from the power stations.

2. Eight 25-cycle company generators with a total capacity of 51,000 kva.
3. The local utility service of 60-cycle power consisting of four 34,500-v circuits with a combined capacity of 160,000 kva.
4. Four 60-cycle company generators with a total capacity of 140,000 kva.
5. The company frequency changer connecting the 25 and 60-cycle systems with a capacity of 20,000 kw in either direction.

The present plant power demand is the result of two somewhat overlapping programs:

1. The 1955 finishing mills expansion program.
2. The 1956 ingot expansion program.

The Sparrows Point plant 60-cycle power distribution consists of two systems. This paper covers first, the expansion of the 34,500-v primary distribution system and second, the expansion of the 6900-v secondary distribution system.

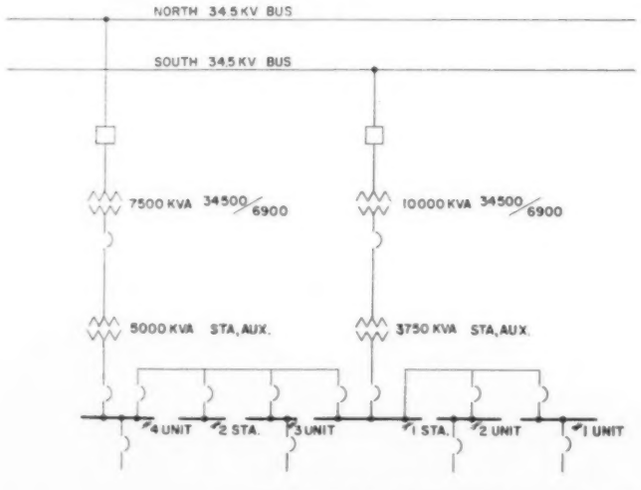
Prior to the recent expansion programs, two 34,500-v circuits with a 40,000-kva capacity each, extended from the Riverside power station of the local utility to the Sparrows Point sheet and tin mill substation. These two lines, carried on wood poles, were "T" tapped in Sparrows Point at three places: the rod and wire mill, the shipyard and the blooming mill before they terminated at the sheet and tin mill substation. The sheet and tin mill substation was the central 34,500-v distribution point. It was becoming a very vulnerable spot through which the bulk of the following source and load power had to pass:

1. The company 60-cycle generation.
2. Frequency changer.
3. Utility tie lines.
4. Sheet and tin mill loads.
5. The 68-in. hot strip mill loads.
6. The 56-in. hot strip mill load.

Serious trouble at this substation might cripple a large section of the plant. It was considered necessary to take steps to decentralize this substation as much as feasible. The following program was carried out and resulted in a 34,500-v transmission system as indicated in the simplified one-line diagram form of Figure 1.

The third and fourth 34,500-v tie lines from the utility were installed as open lines over land and water from Riverside power station to Sparrows Point so that they can be easily converted to 115,000-v circuits in the future. A tentative location for a future 115,000 to

Figure 2 — The Pennwood power station one-line schematic diagram shows how the new No. 4 turbogenerator unit is tied to the existing generator units for supplying power to the 34.5-kv primary system.



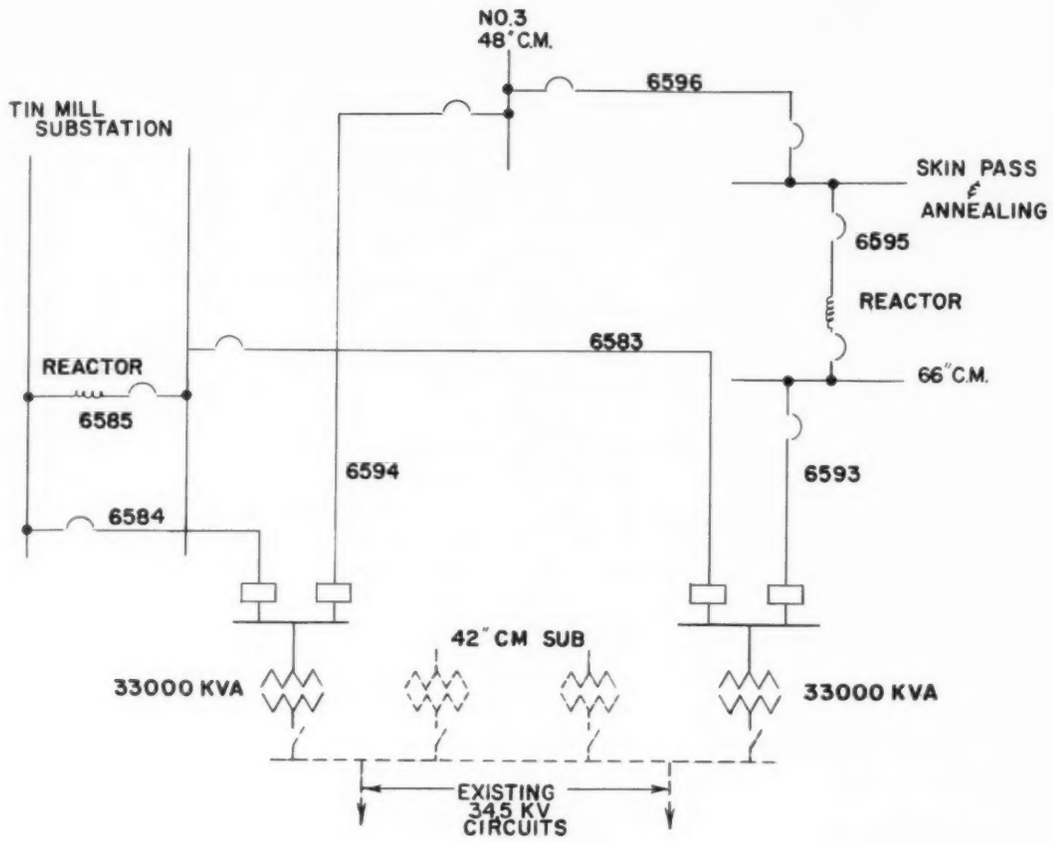


Figure 3 — The 6900-v secondary transmission system of the sheet and tin mill substation is designed so that either 33,000-kva transformer, in the event the other is out, can carry the load of the essential auxiliaries of the impaired transformer in addition to its own load.

34,500-v step-down transformer substation was mapped out for the next large future expansion.

The third 34,500-v tie line was terminated at the 68-in. hot strip mill by adding three 1200-amp oil-circuit breakers with an "in-and-out" scheme feeding two transformers and thence tying to the sheet and tin mill substation using one of the two original circuits that fed the 68-in. hot strip mill from the sheet and tin mill substation. This connection means that during trouble or maintenance work at the sheet and tin mill substation, the 68-in. hot strip mill could be fed from the utility company's tie line only. At the same time the two original 15,000-kva 68-in. hot strip mill transformers, which had carried loads up to 50,000 kva, were changed to 20,000/26,700-kva transformers.

The fourth 34,500-v tie line was planned to be terminated in the future at the 56-in. hot strip if this mill were re-powered. Presently this line terminates at the sheet and tin mill substation.

A West portion of a previously planned 34,500-v loop system was installed from Pennwood power station to the 40-in. blooming mill thus completing two 34,500-v loops. A third oil circuit breaker was added at the 40-in. blooming mill substation to form an "in-and-out" scheme for the existing power transformer as well as a second transformer. The outer or 73 loop was broken into for the 40-in. blooming mill substation. The inner or 74 loop was broken into at another location for a new substation, the electrical repair shop substation which serves the new No. 4 open hearth shop as well as a previously overloaded steel side section of the plant.

All 34,500-v circuits in Sparrows Point have pilot-wire protection as well as back-up inverse-time overload and ground protection. For the original two utility tie lines it meant the original two-terminal line pilot-wire relaying protective scheme had to be revised to a special three-terminal pilot-wire scheme. The scheme, which was satisfactory to both the utility and the company, was worked out jointly with the electrical equipment vendor. The original relays were modified in the shop for the new application and have worked satisfactorily to date.

All 34,500-v breakers are controlled from Pennwood power house by supervisory control. Indications of megawatts, megavars and volts for the 34,500-v circuits also are telemetered and transmitted to the Penwood load dispatcher.

A slow-down and stop-rolling alarm system was provided for the heavy users of power so that the load may be dropped quickly in the event of power trouble. The telemetered megawatt load for each of the four utility company tie lines is passed through the coils of two sensitive control relays. These relays are calibrated to close their contacts at the d-c telemeter output currents equivalent to 40 mw for one and 45 mw for the other. The contacts of the four 40-mw relays are in parallel so that they operate slow-rolling lights in the 56-in. and 68-in. hot strip mills when the load on either line exceeds 40 mw. The contacts of the four 45-mw relays are paralleled to operate stop-rolling lights in the same mills. The Pennwood load dispatcher may also operate either of these alarms manually in the event of other power trouble.

Some of the other interesting points of the plant 34,500-v transmission lines are as follows:

1. Lines from Pennwood to the electrical repair substation and from Pennwood to the blooming mill substation are 1,192,500 circular mil ACSR cable.
2. Cable 33974 from the electrical repair substation

to the blooming mill substation is 795,000 circular mil ACSR cable.

In connection with the ingot expansion program, the No. 4 boiler and its turbogenerator were approved for the Pennwood power station. The No. 4 boiler is an oil and blast-furnace-gas-fired unit. The new boiler has a rating of 500,000 lb of steam per hr at 900 psi and 900 F. The No. 4 generator has a nominal rating of 30,000 kw and is connected to the 34,500-v bus through a transformer in the same manner as the other units. Because the No. 4 boiler and its auxiliaries are somewhat larger than the other units, an additional 5000-kva station auxiliary transformer was installed. The Pennwood 2300-v station auxiliary is indicated in simplified one-line form in Figure 2. Normally units No.1 and No. 2 2300-v emergency tie is fed from the original 3750-kva station auxiliary transformer while No. 3 and No. 4 2300-v emergency tie is fed from the new 5000-kva station auxiliary transformer. These two emergency 2300-v sources can be connected via a tie air circuit breaker and the No. 1 station auxiliary 2300-v bus. In addition to the 2300-v station auxiliary changes, a new station 440-v auxiliary transformer and station lighting transformer were provided with ties to the existing station service.

The 6900-v system was expanded to accommodate the following new loads:

1. New electric weld pipe mill.
2. Tin mill expansion consisting of:
   a. Four trimming and shearing lines.
   b. Four electrolytic tinning lines.
   c. Two 1250-hp air-compressor motors.
3. A 5-stand 48-in. cold mill.
4. A 48-in. continuous pickler.
5. Two twin-stand 48-in. skin pass mills.
6. Four continuous tin plate cleaning and annealing lines.
7. Four additional sintering strands.
8. Additional ore handling facilities.
9. One auxiliary ore bridge with variable voltage control.
10. Extensions to slag and scrap handling facilities.
11. A 4-high 160-in. reversing plate mill.
12. A new 45 x 90-in. slabbing mill.
13. Five soaking pits.
14. No. 4 open hearth shop.
15. Plant utilities air compressor room complete with three 1250-hp compressors.
16. No. 10 blast furnace.
17. No. 12 coke oven battery.
18. No. 13 2000-hp gas pump.
19. Desulphurizer plant No. 4.
20. Extension to water pumping facilities.

Because most of the finishing mills expansion program was in the sheet and tin mill area, the 6900-v, 60-cycle transmission system in this area had to be revised extensively. Figure 3 shows, in one-line form, the 6900-v transmission system that resulted from these changes. Two existing 34,500/6900-v transformers, one 10,000 kva and the other 18,750 kva, were replaced with two 33,000-kva transformers. Two 2000-amp, 14,400-v outdoor oil circuit breakers per transformer were installed as combination secondary and feeder breakers. Cable 6593, which was previously connected solidly to the secondary of the larger transformer, supplies power to the 66-in. cold strip mill. Cable 6583 supplies power to the north tin mill substation bus. The tin mill substation, by the way, supplies all of the power to the ten electrolytic tin lines plus various other finishing operations. Cable 6594 supplies power to the new 48-in. cold mill. Cable 6584 supplies power to the south tin mill substation bus.

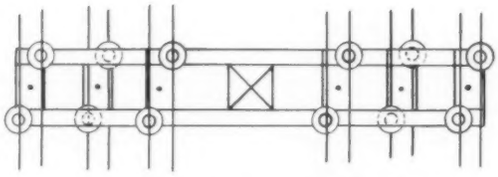
In the original study of this area it was considered very desirable to have two sources of power available for the mill operations. A short circuit study determined that the two 33,000-kva transformer secondaries could not be tied together without exceeding the 500,000-kva interrupting capacity of the existing air circuit breakers. Hence it was decided to install a reactor in each loop at a central load interchange point where the normal flow of power would be at a minimum. With these it is possible to operate essential mill auxiliary equipment from either of the two sources of power during trouble or maintenance of the open lines. For protection each of the lines has two phases with overload relays, one ground relay and pilot-wire line differential. It was not necessary to change the existing 34,500-v lines to this station to carry this additional load.

Some of the interesting points of this section of the expansion are as follows:

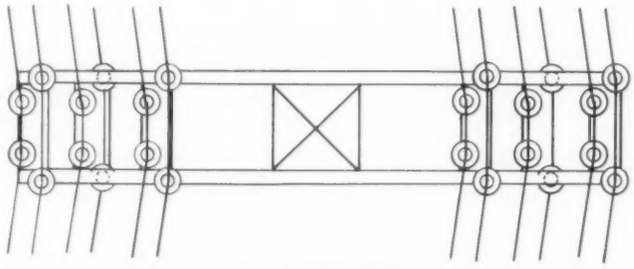
1. Some sections of the risers are 2,500 MCM, single-conductor 15,000-v aluminum cable.
2. The cable from the 42-in. cold mill substation to the 48-in. cold mill consists of four three-conductor, 650 MCM aluminum-armored aluminum cables in parallel.
3. At points the cable between the 66-in. cold mill and the skin pass and annealing substation is more than 125 ft above ground over the mill buildings.
4. Some difficulty was experienced in securing terminals for the aluminum cable because of the large size of the cables.

Also included in the finishing mill program was a new 4-high reversing, 160-in. plate mill. The power supply to

Figure 4 — The increased load of the sintering plant required this new arrangement of pin insulators on the towers.



PLAN VIEW TOWER TC-1



PLAN VIEW TOWER TW-1

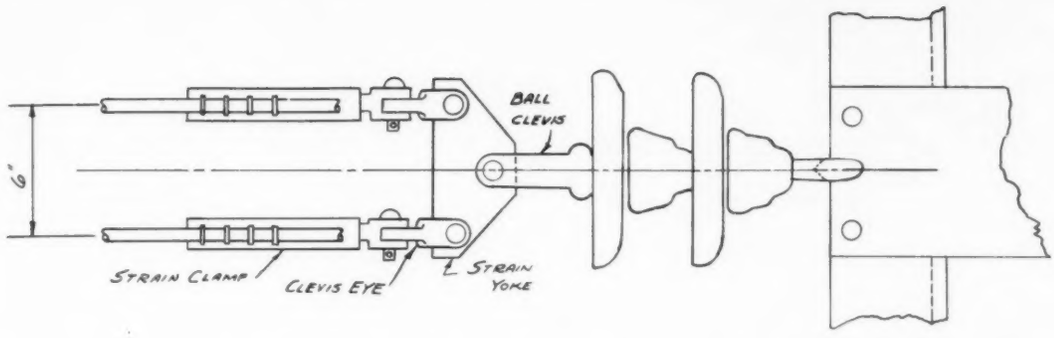


Figure 5 — This yoke is used at the strain insulators.

this mill was completed by extending two parallel feeders of 1,192,500 circular mil ACSR cable from the blooming mill substation. Existing structures for 25-cycle cables were used where possible in installing these feeders. When the new 45 x 90-in. slabbing mill was installed, two parallel feeders of 750 MCM copper were extended from the blooming mill substation to this mill.

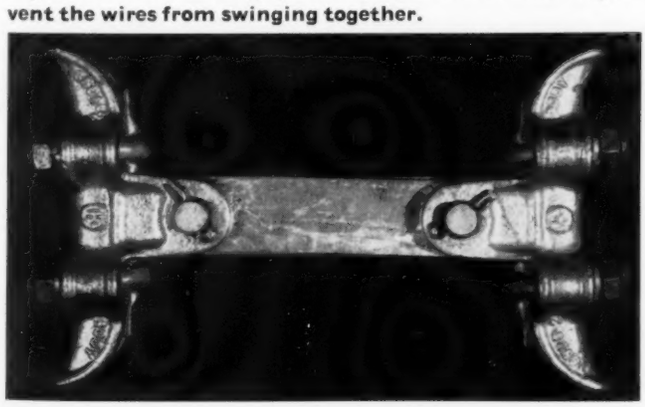
The original two 7500-kva, 34,500/6900-v transformers at Pennwood supplied power for the sintering plant with the original two sintering strands as well as the 60-cycle power for the coke oven, blast furnace and open hearth areas. With the ingot program, the electrical repair substation was completed to supply power for the No. 4 open hearth and to remove the coke oven and blast furnace load from the Pennwood transformers.

The original sintering plant was extended to a total of six strands with a total load of approximately 800 amp. To carry this increased load the existing open 250 MCM weather-proof copper wire was rearranged and one additional 250 MCM wire per phase was added. Figure 4 shows the new arrangement of the pin insulators on the tower. A yoke, shown in Figure 5, was used at the strain insulators, and a spacer, shown in Figure 6, was used between the towers on the long spans to prevent the wires from swinging together.

During the two expansion programs, to better utilize the plant existing 34,500-v to 6900-v transformers, the following changes were made:

1. An 18,750-kva transformer was relocated from the 42-in. cold mill substation to the blooming mill substation.
2. A 10,000-kva transformer was relocated from the 42-in. cold mill substation to the Pennwood station.
3. A 7500-kva transformer was relocated from Pennwood station to the sheet and tin mill substation.
4. A 15,000-kva transformer was relocated from the 68-in. hot strip mill substation to the electrical repair substation.

Figure 6 — On the long spans this spacer was used to prevent the wires from swinging together.



5. A 15,000-kva transformer was relocated from the 68-in. hot strip mill substation to the rod and wire mill substation.
6. A 10,000-kva transformer was relocated from the rod mill substation to the electrical repair substation.

In addition to the above changes, one of the 10,000-kva transformers was used temporarily in six different locations while the existing leaking transformers were being re-gasketed. There were no unscheduled power outages and only a minimum of scheduled power outages to accomplish these expansions.

Discussion

PRESENTED BY

H. R. KNUST, Assistant General Manager, Bethlehem Steel Co., Sparrows Point, Md.

H. H. ANGEL, Electrical Engineer, Construction Engineering Dept., Bethlehem Steel Co., Bethlehem, Pa.

H. W. DORSET, Assistant Superintendent, Electrical Dept., Bethlehem Steel Co., Sparrows Point, Md.

JAMES M. TILLMAN, General Foreman, Power House, Electrical Dept., Bethlehem Steel Co., Sparrows Point, Md.

H. R. Knust: The over-all planning and supervision of the job was handled by our own construction department with the service departments and the operating departments.

The service departments and the operating departments had to keep the plant maintained and operating at maximum production levels while building another plant around it.

H. H. Angel: In October the electrical power consumption was about 140,000,000 kwhr. I think the one-hour demand or the instantaneous peaks might be of interest.

Many years ago, especially when one generating unit was down for inspection, a critical situation existed whereby it was necessary to watch the loading very carefully so that the power company would not trip their circuits due to excess current in their conductors, especially where the three conductor cables were used in part of the transmission.

Mr. Tillman mentioned that all of the 60-cycle circuits are controlled from the Pennwood power house by supervisory control. That, of course, is very helpful during a bad storm or when you have trouble because it

enables you to know what is going on without leaving the powerhouse. It is especially helpful to have the organization set up so that when trouble occurs, say at 2:00 o'clock in the morning, the personnel can very efficiently handle their system so that only a minimum of downtime is required for repair. I know that problem exists in all our plants. I know some of them have good supervisory control while others do not have the ideal setup but are hoping to improve conditions in the next few years.

H. W. Dorset: Of the four 34-kv lines that come from the Riverside station of the public utility the two original lines are under Bear Creek and consists of something like three 350,000-circular mill, three-conductor cables in parallel per circuit. The third line laid across Bear Creek was added at a point one-half mile north of the two original lines. That also was put under water. Due to certain changes we had made and the necessity to move a couple of very high steel towers that the public utility had erected to span Humphries Creek, a distance of 1200 ft; it was possible, when the fourth line was installed, to take those two towers down because of the fill. In their place a wood pole line was set. Those two towers with two additional steel towers were used to carry the fourth 34-kv line over Bear Creek. Only this fourth circuit is above ground at that location. It consists of 750,000 circular mill copper. The third line still remains under water, but if we ever expand the plant and need more power than we have now, the insulation spacing on the cross arms, etc., is spaced on the insulator strings for a 110-kv system. This line can be quite readily converted from 34 to 110 kv, and the third line now under water at this location can be put up on the towers to carry two three-phase, 110-kv lines. This will bring in several times the capacity we now have in the 34-kv lines. The public utility has about reached its limit on the supply of 34-kv power.

James M. Tillman: The indicated peak plant load is 275 megawatts with a maximum integrated hourly load of 240 megawatt-hours.

We do have supervisory control on all of our 34,500-v cables, but we do not now have supervisory personnel on a 24-hr per day basis. One instance occurred at 4 A.M. We were called out to locate the trouble on 34,500-v lines that had tripped. When we pointed a light up into the substation structure, we saw a cat's eyes shining down. The cat had climbed up the steel structure and on to an insulator. ▲

Tube Mill Practice

A selection of articles from the IRON AND STEEL ENGINEER on various phases of tubemaking.

(Published in 1953)

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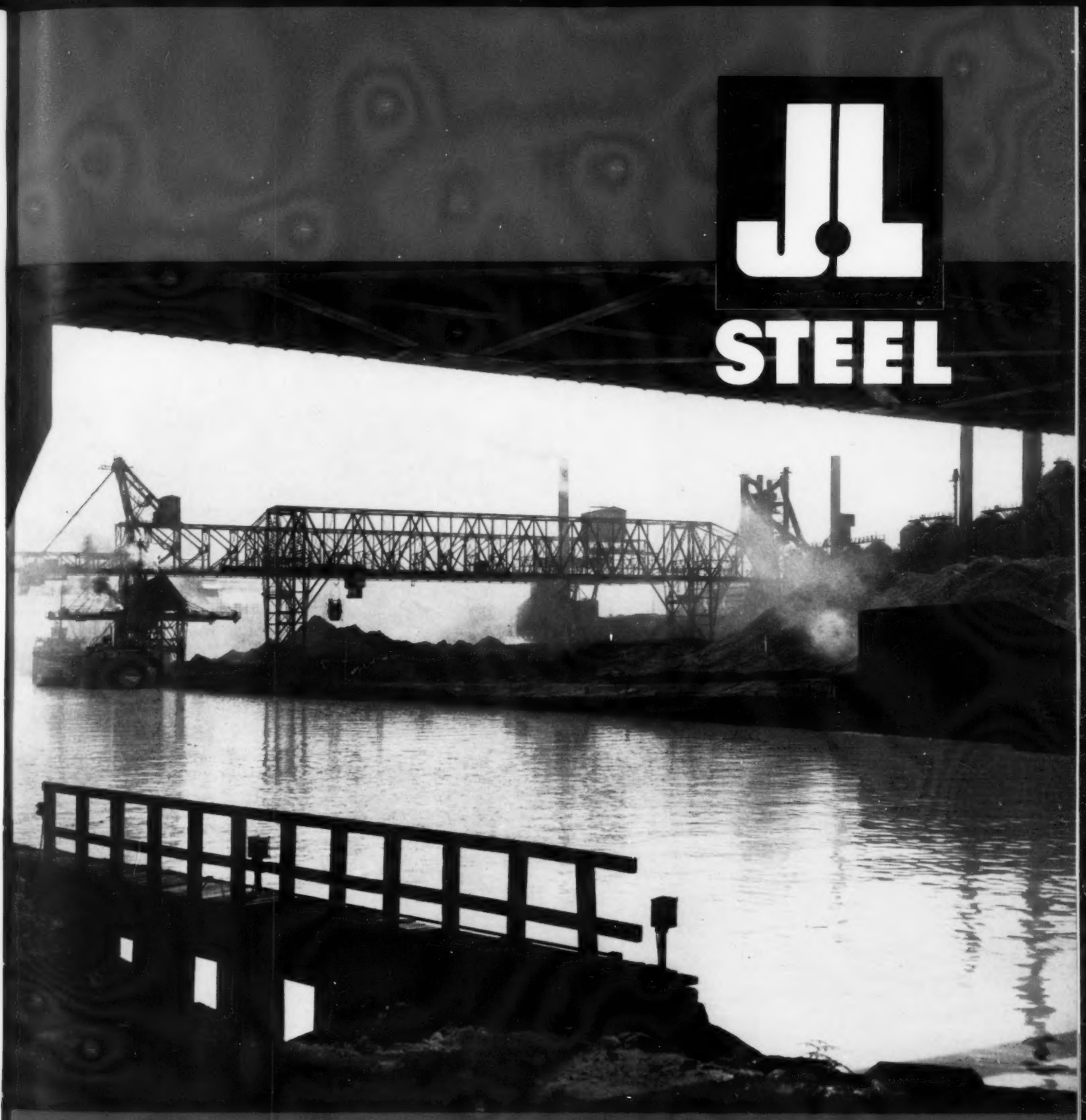

Jones & Laughlin . . .

CLEVELAND WORKS

STEEL

Jones & Laughlin . . .

CLEVELAND WORKS

By T. J. Ess

THE Cleveland Works of Jones & Laughlin Steel Corp. has an important spot in the history of the American iron and steel industry, for it was here that much of the pioneering on the basic open hearth process was done.

The plant had its origin in a company started in 1874 (1873) by Charles Otis, who had obtained a license to use Siemen's open hearth process in the United States. Prior to this, Otis had inherited an iron furnace in Cleveland which he expanded with the addition of a forge shop and rolling mill for the production of iron bars and railroad axles. The new plant also included a seven-ton acid open hearth.

In 1889, control of the company passed to an English holding company. This continued for 30 years, when the company was acquired by a group of Cleveland bankers and industrialists. During this time, the present plant site on the Cuyahoga River was acquired.

Purchase of the adjacent Cleveland Furnace Co., with a by-product coke oven plant and two blast furnaces gave the company its supply of iron.

The ensuing years brought gradual expansion with the addition of more sheet mills, more open hearth furnaces, a 40-in. blooming mill, and hot and cold strip mills.

In 1942 Otis Steel Co. was acquired by Jones & Laughlin, and a vast program of expansion and rehabilitation was started. To date, it has cost $90,000,000 and has involved sintering facilities, blast furnace replacement and enlargement, electric furnaces, soaking pits, slabbing mill, scarfing machine, reversing rougher for the strip mill, pickling line, tandem cold mill, temper mills, shearing lines and annealing facilities, as well as much auxiliary equipment, building extensions and utility services.

At present, the Cleveland Works has integrated facilities for the production of 324,000 tons of coke, 866,000 tons of iron, 1,525,000 tons of open hearth steel and 420,000 tons of electric furnace steel per year.

RAW MATERIALS

Iron ores for Cleveland Works come from Minnesota, Michigan and New York. Analyses of the principal ores are given in Table I. The Lake ores arrive in lake carriers which proceed up to the Cuyahoga River to the plant docks. The carriers are unloaded by two 5-ton unloading

TABLE I
Iron Ore Analyses

Source	Per cent (dry)								
	Iron	Silica	Phos-phorus	Man-ganese	Alumina	Lime	Mag-nesia	Sulphur	Ignition loss
Minnesota Ore Division									
Mesabi Range	57.58	9.45	0.064	0.63	1.31	..	..	...	..
New York Ore Division									
Benson Mines	62.51	6.03	0.107	0.18	2.95	..	..	...	..
Michigan Ore Division									
Marquette Range	59.02	8.70	0.087	0.32	2.71	..	..	2.19	..
Plant sinter	60.00	11.03	0.06	0.46	1.50	0.53	0.07	0.022	..

towers and a 17-ton combination unloader and bridge. The towers deposit ore in a trough, from where a 15-ton bridge moves it to storage. The combination unit moves ore directly from boat to storage.

New York ores arrive in railroad hopper cars and are usually unloaded on the blast furnace high line directly into the stock bins.

The Lake ores are graded at the mines and some are washed and screened. New York ores are beneficiated and sintered at the mine.

Ore is reclaimed from storage by the bridges and placed in a 50-ton transfer car which dumps into the stock bins.

Blast furnace limestone comes from quarries in Michigan in self-unloading lake carries which deliver the stone directly to a stock pile in the storage yard. From the stock pile, stone is reclaimed by the ore bridge, placed into a diesel-powered transfer car and dumped into the stock bins.

Open hearth stone is trucked from a public lake front dock to overhead bins in the open hearth stockyard.

All stone is sized and screened at the quarries to 3 in. x 5½ in. Analyses of limestone and dolomite are given in Table II.

Coal comes from mines in West Virginia and Virginia. It is washed and sized at the mines. Arriving in railroad hopper cars, coal is usually delivered directly to the coke plant, where it is dumped into track hoppers. If it is necessary to stock coal, cars are delivered to the stockyard and unloaded by locomotive crane. It is reclaimed from storage by locomotive crane which loads it into railroad cars. Coal storage is approximately a 30-day supply and is used only in emergencies. Coal analyses average about as given in Table III.

TABLE II
Limestone and Dolomite Analyses

	Limestone, per cent	Dolomite, per cent
SiO_2	0.63	0.53
Al_2O_3	0.65	0.46
CaO	53.67	30.39
MgO	1.42	21.44
S	0.085	0.035

TABLE III
Coal Analyses

Source	Per cent				
	Mois-ture	Volatile matter	Fixed carbon	Ash	Sulphur
Island Creek—Blue Boy	4.50	25.0	70.0	5.0	0.60
Pittston No. 9	4.00	32.0	62.0	6.0	0.70

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Works Manager

WILLIAM P. SMITH

Assistant Works Manager

At capacity operations, raw material consumption is approximately as follows:

	Net tons per month
Iron ores to sinter plant	85,500
Iron ores directly to blast furnace	55,700
Iron ores to open hearth and electric furnaces	10,800
Coal to coke plant	39,000
Limestone to blast furnaces	29,500
Limestone to open hearth and electric furnaces	7,800

Storage capacity for raw materials is as follows:

	Storage area, sq ft	Capacity, tons
Iron ore	284,000	730,000
Coal	86,000	38,200
Limestone	115,300	168,000

COKE PLANT

Three batteries of by-product coke ovens provide facilities for coking about 1350 tons of coal per day. Characteristics of these batteries are as follows:

No. 1 battery—24 ovens, 15 to 17 in. wide, 34 ft-4 in. long, 9 ft-2¾ in. high; coal capacity 9½ tons per charge.

No. 2 battery—25 ovens, 15 to 17 in. wide, 35 ft-4 in. long, 9ft-2¾ in. high; coal capacity 9½ tons per charge.

No. 3 battery—51 ovens, 16 to 18 in. wide, 35 ft-8¼ in. long, 9 ft-9⅝ in. high; coal capacity 10½ tons per charge.

Coal is unloaded directly from hopper cars by gravity into the hoppers of three 250-ton per hr breakers, where it is crushed to 2 in. if necessary. It is then moved by belt conveyor to three holding bins. High and low volatile coals are kept separate to this point.

From the holding bins, coal flows through manually controlled feeder gates on to a mixing conveyor, which carries it to a 300-ton per hr pulverizer. The coal mix generally consists of 12 per cent low volatile, 88 per cent high volatile. It is pulverized so that about 65 per cent passes through a ⅛-in. screen.

From the pulverizer, belt conveyors carry the coal mixture to the two oven bins, from which two 12-ton, four-hopper charging larries take it to the ovens.

The ovens are designed with horizontal heating flues and are fired with coke oven gas. No. 3 battery is of re-

ROGER M. WOLCOTT

Assistant Works Manager

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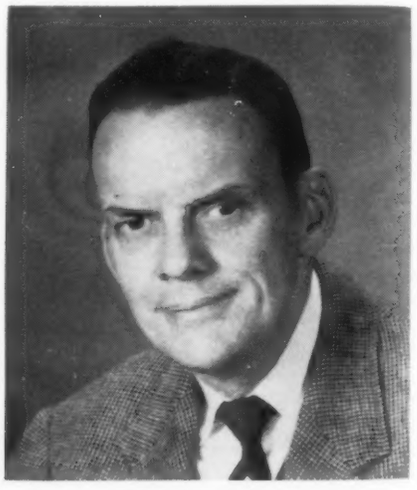
Assistant to Works Manager



PAUL W. MARTIN

Assistant to Works Manager—
Personnel Relations

Lake carriers bring iron ore from the upper lake ports directly to the plant docks on the Cuyahoga River.

generative design while No. 1 and 2 are of an older recuperative design which gives little preheat to the combustion air but recovers sensible heat from the flue gases by waste heat boilers. These boilers make 1250 lb of steam per ton of coal charged to the ovens. All of this steam is used in the coke plant.

Under normal conditions, 134 ovens are pushed per day, giving a gross coking time of 17.8 hr.

The ovens are served by the usual pushers, door machines, quenching car, etc. Coke is pushed into the quenching car, quenched by automatically timed sprays in the quenching station and dumped on the coke wharf. After cooling, it is conveyed to screening stations. Furnace coke (over 1¼ in.) is conveyed to the coke bins at the blast furnaces. Coke passing through the 1¼-in. screens is further sized into plus ¾-in. nut coke (also used in the furnaces), ¾-in. x 3/16-in. pea coke (which is sold) and minus 3/16-in. breeze for use in the soaking pits and sintering plant.

By-product recovery equipment is conventional, with tar decanters, primary coolers, four rotary positive displacement exhausters, electrostatic tar precipitator, two spray type ammonia scrubbers, an ammonia concentration still, wash oil scrubbers, oil-to-oil heat exchanger, wash oil heater, wash oil still and dephlegmator. The light oil is not fractionated, but is sent to the corporation's Aliquippa plant for further processing.

Coke oven gas goes to the three oven batteries for fuel, while surplus gas is sent at 3-psi pressure by three rotary boosters to the steel plant and to the sinter plant. A 10,000-cu ft gas holder is on the gas system.

Coke yields average 71 per cent furnace and nut coke and 2.75 per cent breeze. By-product yields average as follows:

	Per ton of coal
Gas, cu ft	10,200
Tar, gal	8.5
Light oil, gal	2.75
Ammonia liquor (18 per cent NH_3), lb	4.53

The ovens consume 52 per cent of the gas make overall, with the regenerative ovens using about 45 per cent of their gas make and the older ovens consuming about 75 per cent of their make. Thus, about 200,000,000 cu ft per month of surplus coke oven gas is available for use elsewhere.

BLAST FURNACES

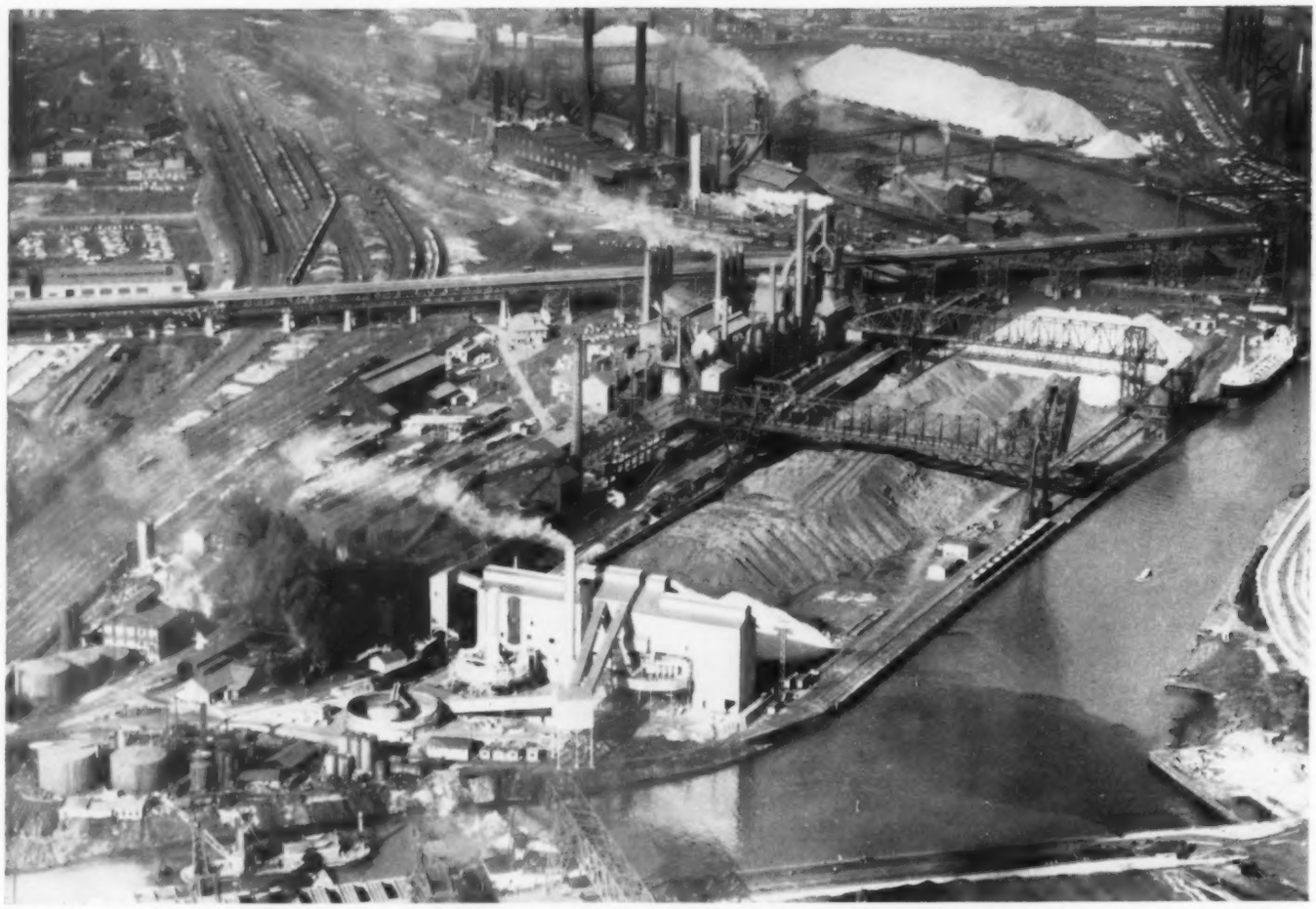
Ironmaking capacity of 866,000 net tons per year is provided by two blast furnaces built to the proportions given in Table IV. No. 1 is a new stack put into operation in 1952, replacing one of the old furnaces. No. 2 furnace was originally built in 1902 but was rebuilt and enlarged in 1949.

Both furnaces are cooled by cooling staves around the hearths and by bronze cooling plates in the walls up through the boshes. Manganese steel wearing plates embedded in the brickwork protect the stockline sections.

Each furnace is filled by a conventional motor-driven double skip hoist. Skip cars on No. 1 furnace are of 200 cu ft, on No. 2 furnace, of 120 cu ft capacity. These cars dump into rotating distributor tops. Bell hoists on No. 1 furnace are electrically operated, those on No. 2, hydraulically. No. 1 furnace is equipped with automatic charging control.

TABLE IV
Blast Furnace Data

	No. 1	No. 2
Diameter of hearth, ft-in.	25-9	20-1
Diameter of bosh, ft-in.	28-9	23-0
Diameter of stockline, ft-in.	20-0	17-0
Height, iron notch to stockline, ft-in.	86-5 3/8	73-2 1/4
Height of crucible, ft-in.	11-9	5-0
Height of bosh, ft-in.	10-0	19-6 1/2
Height of straight section, ft-in.	9-6	13-7 1/2
Height of inwall section, ft-in.	52-8 3/4	39-10 1/4
Height, stockline section to top ring, ft-in.	15-3	13-2
Height, bottom to iron notch, ft-in.	2-0	2-0
Height, iron notch to cinder notch, ft-in.	4-8	4-0
Height, cinder notch to tuyeres, ft-in.	3-4	7-3
Working volume, tuyeres to stockline, cu ft	38,870	21,411
Bosh angle, deg-min-sec	81-28-9	83-13-11
Inwall slope, in. per ft	0.996	0.887
No. of tuyeres	16	12
Tuyere diameter, in.	6 1/2	6 1/2
No. of columns	8	6
Lining thickness, crucible, in.	36	36
Lining thickness, bosh, in.	27	31
Lining thickness, stack, in.	45	40 1/2
Lining thickness, throat, in.	48	31 1/2
Big bell diameter, ft-in.	15-0	12-0
Big bell angle, deg	53	50
Small bell diameter	6-6	6-0
No. of stoves	5	4
Stove diameter, ft	(1) 26, (4) 22	22
Stove height, ft	(1) 125, (4) 102	91
Checker openings, in.	(1) 2 (3) 4 3/8, inserts (1) 4 3/8	(1) 1 15/16 (1) 2 (2) 4 3/8, inserts
Total heating surface per stove, sq ft	685,816	460,482
Blast volume, average, cfm	79,800	50,800
Blast volume, maximum, cfm	86,000	57,000
Blast temperature, average, F	1130	990
Blast temperature, maximum, F	1400	1150
Average blast pressure at tuyeres, psi	22	18
Average top pressure, psi	3.06	1.8



This view of the coke plant and blast furnace area shows the new sintering plant in the foreground.

On both furnaces, ore and stone are charged by weight. Coke is charged by weight for No. 1 furnace, by volume for No. 2. The normal charging sequence is O-S-C-O-C-C. Ore and stone are moved from the stock bins to the skip cars by conventional scale cars.

Blast for the furnaces is provided by three turboblowers: one rated at 100,000 cfm, 30 psi, driven by an 11,650-hp, 2650-rpm turbine; one rated at 60,000 cfm, 30 psi, driven by a 6800-hp, 3150-rpm turbine; one rated at 45,000 cfm, 23 psi, driven by a 4450-hp, 3550-rpm turbine. The third unit is used as a stand-by. All three run on 225-psi steam and are equipped with barometric condensers.

On No. 1 furnace, moisture content of the blast is automatically controlled, usually at 5 gr per cu ft, by the addition of steam.

Blast is heated by nine two-pass stoves (five for No. 1 furnace, four for No. 2). Stove dimensions are set forth in Table IV. Checkerwork varies, but is principally of basket weave type with inserts. Stoves are generally operated six hours on gas, two hours on blast. Automatic mixer valves control hot blast temperature.

Stoves consume about 48 per cent of the blast furnace gas, which is burned through pressure type proportioning burners. Stove stack temperatures range 350 to 400 F.

Gas leaves each furnace through four offtakes, 8 ft in diameter on No. 1 furnace, 4 ft-3 in. on No. 2. Top temperatures may range from 220 to 500 F. No. 1 furnace has a single downcomer, No. 2 furnace has two. Gas from each furnace passes through a dust catcher, a wet washer and an electrostatic precipitator. This combination cleans gas to a dust content of 0.025 gr per cu ft. Surplus gas is used to underfire boilers.

Effluent from the washers flows to a 90-ft diam, 16-ft deep thickening unit of 6900-gpm capacity. The sludge recovered here is reclaimed for use in the sintering plant.

The furnaces are cast every 4 hr-48 min into mixer type ladles which are usually taken to the open hearth. The iron produced is a medium manganese basic iron approximating the following percentage analysis:

Silicon	0.75–1.05
Sulphur	0.04 max
Phosphorus	0.2 max
Manganese	0.05–1.00

In emergencies or when not required at the open hearth, iron can be put over two double-strand pig machines.

The furnaces consume about 3000 lb of iron ore, 1400 lb of coke, 750 lb of limestone and 300 lb of scrap and miscellaneous materials per net ton of iron produced. They produce about 2500 tons of iron per day.

Slag production runs 800 to 900 lb per ton of iron, and flue dust averages 75 lb per ton. Slag usually falls into the following range:

	Per cent
SiO_2	35.1–35.8
Al_2O_3	11.0–11.4
CaO	43.2–44.0
MgO	6.2–6.4
S	1.35–1.78

Slag from the furnace is run into ladle cars and moved to granulating pits. It is sold to an outside company.

An important unit in the recent improvement program is the new sintering plant, rated at 2500 net tons per day. Of traveling grate design, the sinter strand is 128 ft long x 8 ft wide, and is composed of 95 pallets 3 ft-6 in. x 8 ft. There are 16 windboxes. The normal charge forms a bed 12 to 16 in. deep. Machine speed ranges 26 to 158 in. per min. Draft is provided by a fan rated at 280,000 cfm, 300 F, 30-in. water column.

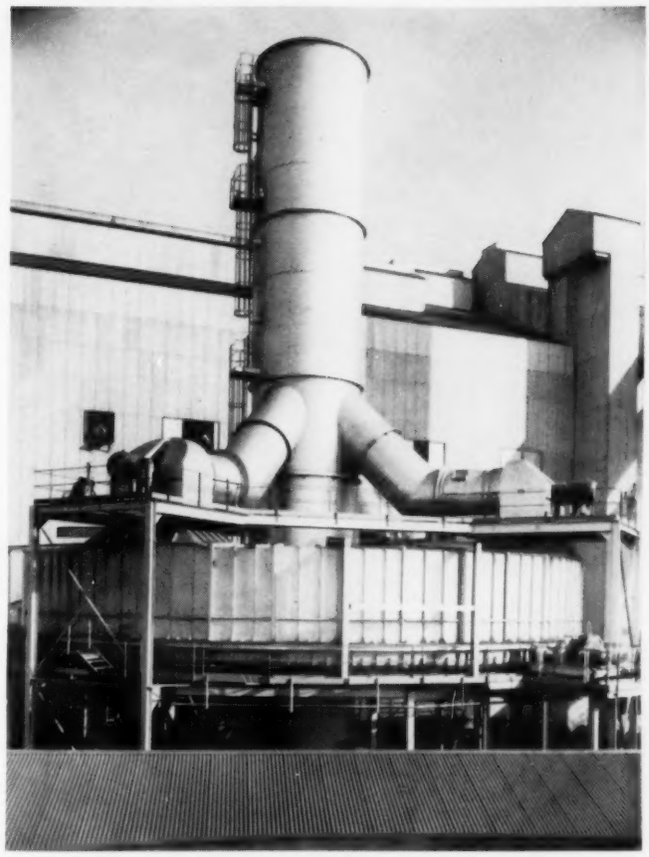
The sinter strand discharges on to a circular cooler of 65 ft average diameter. The trays of this cooler are 7 ft wide and provide an active cooling area of 1090 sq ft. Draft for the cooler is provided by three fans giving a total capacity of 450,000 cfm at 300 F, 2-in. water column. These fans draw air up through the sinter bed, where air is collected and vented through a stack 16 ft in diameter and 100 ft high.

Cooling time can be varied from 15 to 45 min, but runs about 20 min at full production, during which time the sinter cools from 1300 F to about 200 F.

Components of the charge mix are pugged in a 200-ton per hr pug mill and conditioned in an 18-ft tilted saucer. Any combination of these units can be used in preparing the mix.

Twelve automatic weighing units weigh materials moving over conveyors at every important stage of the sintering operation. These units operate by determining the weight on a short section of belt and integrating that with belt speed.

With two-furnace operation, sinter will form about 60 per cent of the ore charged to the furnaces.



Sinter is discharged to this circular cooler. Approximately 450,000 cfm of air are drawn up through the sinter by three fans and exhausted through the stack.

OPEN HEARTH

The open hearth shop contains 11 furnaces, eight rated at 175 tons, three at 210 tons.

The 175-ton furnaces have bath areas 44 ft long x 14 ft wide. They are constructed with basic front, back and end walls. The 210-ton units provide baths 52 ft long x 16 ft wide. They have basic construction in front, back and end walls, port roofs and uptakes, and the backwalls are sloping.

The roofs of eight furnaces are sprung arches of silica brick 15 in. thick with 21-in. ribs. Three furnaces have sprung arch basic roofs with oxygen lances. Furnace bottoms are 31½ to 37 in. thick, consisting of fire clay brick, up to 18 in. of chrome brick and 9 to 15 in. of rammed magnesia refractory.

The larger furnaces have single regenerator chambers with flat suspended roofs on each end of the furnace. They are 27 ft long x 23 ft wide and contain checkerwork 13 ft-10½ in. deep. The smaller furnaces have double regenerators 30 ft-10 in. long, 11 ft-8 in. and 8 ft-2 in. wide, with checkers 11 ft-1½ in. deep. Checkers are constructed of 9-in. x 4½ in. x 3-in. brick, forming 6-in. x 6-in. flues.

All furnaces are fired with bunker C fuel oil and natural gas in proportions of about 75 per cent oil, 25 per cent gas. Fuel is introduced through water-cooled, double-barreled artillery type burners. Fuel consumption averages 3,900,000 Btu per ton of steel. Maximum firing rates are 71,000,000 Btu per hr for the smaller furnaces and 85,000,000 for the larger ones.

Oil comes to the plant by pipeline from a nearby refinery. Four storage tanks provide a total capacity for 7,600,000 gal of oil. A 125-gpm, 175-psi recirculating system serves the open hearth shop. Each furnace is equipped with an individual oil heater rated at 600 gphr, 150 psi, which heats the fuel oil to 200 to 220 F under automatic control.

Air for combustion comes from individual fans for each furnace, rated 22,500 cfm for the 175-ton furnaces, 50,000 cfm for the 210-ton furnaces.

Each furnace is provided with controls and instruments on fuel flow, air flow, fuel-air ratio, oil temperature, oil pressure, furnace pressure, roof temperature and bath temperature. Furnace pressure is maintained at 0.001 to 0.003 psi.

Furnace charges consist of 42 to 65 per cent of hot metal, the remainder of No. 1 and 2 heavy melting and No. 1 and 2 bundled scrap. The 175-ton furnaces take a 408,000-lb charge, the 210-ton furnaces take a 512,000-lb charge.

Oxygen, injected into the bath through lances in the wicket holes of the doors, is used for decarburization of the bath. This usage at present consumes 100 to 150 cu ft of oxygen per ton of steel produced.

Time of heats average 10.7 hr, charge-to-tap, 11.8 hr tap-to-tap. Production rates run 16.3 tons per hr charge-to-tap, 15.0 tap-to-tap on the smaller furnaces. The large furnaces produce 21 tons per hr, charge-to-tap, 19.2 tons per hr, tap-to-tap.

Flux consumption per ton of steel averages 120 lb of limestone, 15 lb of burnt lime and 4.5 lb of fluorspar.

Eleven open hearth furnaces provide annual capacity for 1,525,000 tons of open hearth steel. Three of the furnaces have roof oxygen jets.

Consumption of deoxidizers and alloy additions average as follows:

	Lb per ton of ingots
50 per cent ferro silicon	0.7
Aluminum	0.8
Standard ferromanganese	12.6
Medium carbon ferromanganese	1.25
Ferrophosphorus	0.3
Silico-manganese	0.6
Ferrovanadium	0.02

Deoxidizing is done either entirely in the ladle or partially in the ladle and partially in the molds.

Steel is produced in rimmed, semi-killed and killed types in low carbon and low alloy, high strength grades. Analyses fall into the following general ranges:

	Per cent
Carbon	0.05 –0.40
Manganese	0.25 –1.50
Phosphorus	0.005–0.13
Silicon	0.01 –0.25
Sulphur	Under 0.035

Steel is tapped into 175 or 225-ton ladles and poured into big-end-down ingots ranging from 24 to 27 in. thick x 42 to 72 in. wide x 68 to 76 in. long, and 16,000 to 34,000 lb in weight. Tapped weights run about 354,000 lb from the small furnaces, 449,000 lb from the large ones.

Before each use, molds are dipped into or sprayed with a graphite base solution.

Slag, which runs about 240 lb per ton of steel produced, is flushed into slag pots, moved to a dump and broken up. It is processed by an outside company to recover metallics.

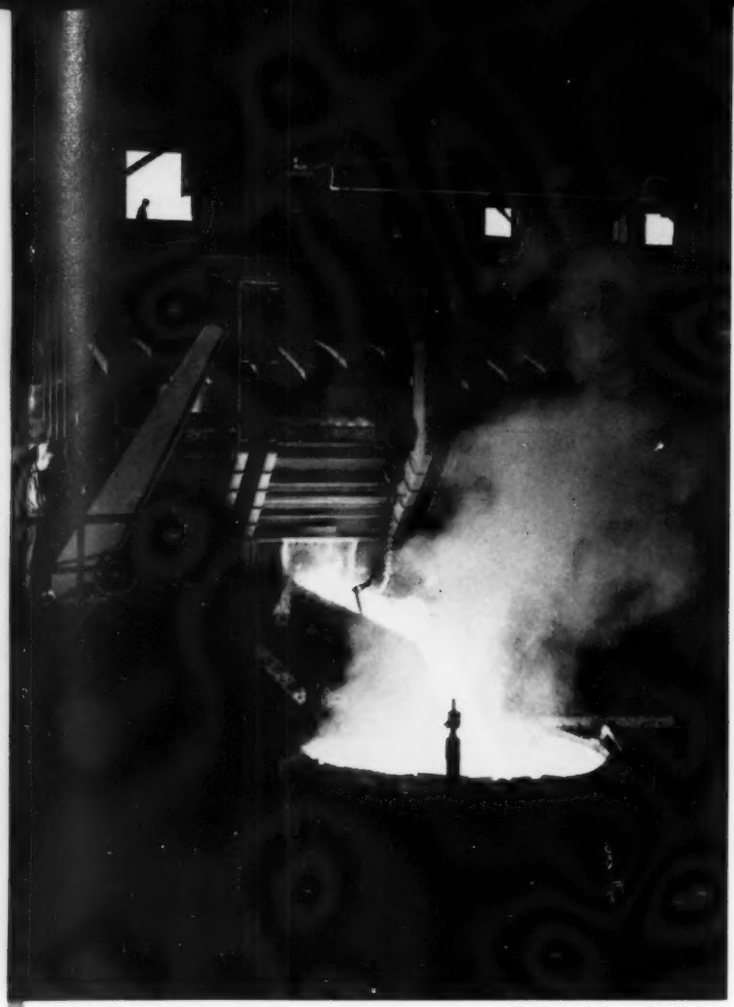
Miscellaneous equipment in the open hearth includes two dolomite machines, a hydraulic stopper rod press and a stopper rod oven.

Open hearth buildings include the charging bay, 1185 ft x 92 ft with three 100/25-ton cranes; the pouring bay, 1185 ft x 71 ft, with three ladle cranes of 175, 200, and 250-ton capacities, respectively; the mold building, 350 ft x 76 ft, with two 25/15-ton cranes; the stripper building, 230 ft x 76 ft, with one 200-ton stripper crane; and the unroofed stockyard, 1200 ft x 96 ft, with three 10- or 15-ton cranes.

ELECTRIC FURNACES

Another recent major addition are two 125-ton electric arc furnaces, installed in 1957. These are located in a building 250 ft x 158 ft near the north end of the soaking pits.

The department is laid out to receive scrap in gondola cars, which are unloaded by crane and magnet directly into 200-cu ft charging buckets. Ferro-alloys and miscellaneous materials are trucked in and stored in



Heats are tapped in about 11 hours into 175 or 225-ton ladles and poured into big-end-down ingots.

stock bins on the charging floor. A 5-ton diesel-powered mobile floor charger puts such materials into the furnaces. The charging floor is served by one 100/25-ton crane. The pouring aisle has one 200/50/15-ton ladle crane. A 20/5-ton crane serves the scrap bay.

The furnaces are of top-charge design with shells 22 ft in diameter and 8 ft-6 in. high from sill plate to the top of shell, fabricated from $\frac{3}{4}$-in. welded steel plate. Furnace walls are of steel-cased basic brick 13 in. thick. Roofs are of silica brick, 15 in. thick, constructed with expansion allowance of $\frac{1}{16}$ in. per ft.

The furnaces are tilted by electric motors operating through reduction gearing, with the furnace tilting on toothed rockers riding on toothed rails.

Each furnace has three graphite electrodes, 24 in. in diameter. These are clamped in electrode arms supported by vertical masts which are raised and lowered by electric motors working through gear reductions and cables. The 15-hp electrode motors operate under adjustable voltage control with rotating amplifier regulators. Electrode speeds up to 12 fpm are available.

Each furnace has a three-phase 30,000-kva transformer, with forced oil and forced water cooling, designed for a 55 C temperature rise. Primary voltage is 22,000, which may be connected in delta or wye. With the delta connection, the six secondary voltage steps give 470, 430 and 390 v with full capacity, and 350, 310 and 270 v with reduced capacity. With wye connections the same taps give 275, 250, 226, 203, 180 and 156 volts. Taps are changed on the high voltage side by links and motor operated tap changer. The transformers have inherent reactances of 5 per cent. A three-pole air blast circuit breaker rated at 34.5 kv, 1200 amp is installed on the high voltage side of each transformer.

The furnace breakers are set to operate on ordinary overloads. Abnormal overloads will operate the primary breakers in the substation.

A demand meter in the substation, hooked into the over-all plant demand, signals the electric furnace operator if the plant load should become excessive.

Secondary current is carried from the transformer to the electrodes by air-cooled cables, each phase consisting of forty 1,750,000-circular mil cables.

Thus far, these furnaces have not been put into operation, since the company has adequate electric furnace capacity at its Stainless and Strip Division in Detroit.

The Cleveland furnaces were intended to produce low carbon steels of 0.05–0.40 per cent carbon with single slag practice. A total charge of 265,000 lb is planned, with 85 to 90 per cent scrap and 15 to 10 per cent cold iron. It is estimated that such heats will be made in five hours.

Steel will be tapped into 140-ton ladles and poured into big-end-down ingots 24 to 27 in. thick, 42 to 72 in. wide and 68 to 76 in. long.

It is estimated that the furnaces will consume about 500 kwhr per ton of steel produced, with each furnace setting up a demand of 23,000 kva and an average load of 14,000 kw.

BLOOMING MILL

Another major unit in the modernization of Cleveland Works is a 46-in. high-lift blooming mill designed to provide 140,500 net tons of slabs per month.

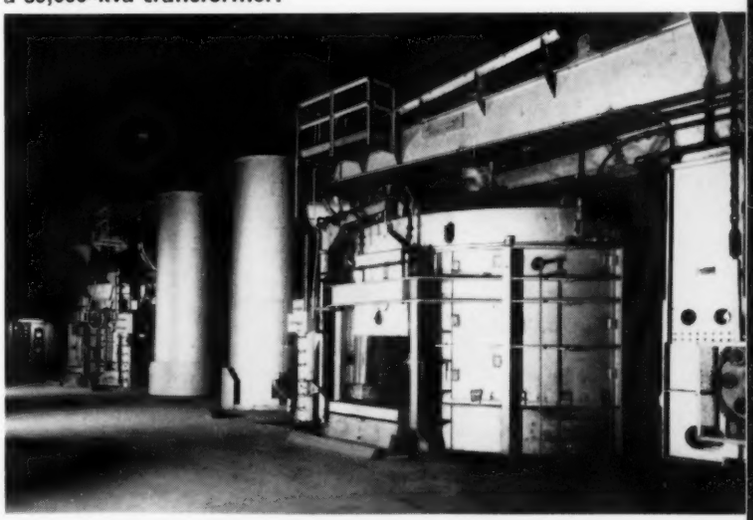
The new mill is served by 21 soaking pits of varying types and sizes:

Ten one-way recuperative pits, 27 ft long x 9 ft-6 in. wide x 13 ft-6 in. deep.

Eight one-way recuperative pits, 21 ft-6 in. long x 7 ft wide x 11 ft-6 in. deep.

Two reversing, regenerative pits, 16 ft long x 11 ft wide x 10 ft-6 in. deep.

Part of the recent expansion, these 125-ton arc furnaces, have not yet been operated. Each furnace is equipped with a 30,000-kva transformer.



One reversing, regenerative pit, 14 ft long x 7 ft wide x 8 ft-6 in. deep.

The pits are fired with coke oven gas and natural gas, the latter flowing in when coke gas pressure drops below a predetermined point. Air for combustion is furnished by eight fans of various ratings.

Except for the one small pit, the pits are equipped with automatic controls on fuel-air ratio, furnace pressure and temperature.

Track time for the ingots averages about three hours. Ingots are usually charged to the pits at temperatures of 1500 to 2000 F, although 5 to 7 per cent may be charged cold. Usual heating times run 4 to 5 hr for hot ingots, 12 to 14 hr for cold ingots. Fuel consumption averages 1,100,000 Btu per ton of ingots charged.

Ingots are charged and drawn by two 25-ton pit cranes. The heated ingots, ready for rolling, are placed by the cranes in an ingot buggy which carries them to the mill. This buggy operates on a track in line with the mill tables. It is of front tilt type, actuated by a cam, and carries its own drive motor, for which power is drawn from collector rails.

The ingot receiving table is 9 ft-4 in. long and is provided with a cam casting that engages cam levers on the side of the ingot buggy, causing the latter to tilt.

The mill approach table, about 29 ft-5 in. long, is equipped with an ingot scale. This scale has motor-driven cantilever beams which lift the ingot from the table, permitting its weight to be recorded.

The blooming mill is a two-high, high-lift reversing unit designed to roll slabs 24 in. to 72 in. wide and 4 in. to 8 in. thick. The cast steel housings are of closed type, with each post offering a cross section of 603 sq in.

Cast alloy steel rolls of 120 in. body length and about 45 in. diam carry grooved passes of $6\frac{5}{8}$ in., $8\frac{1}{8}$ in. and 12 in., and a 76-in. slab pass. Roll necks are 28 in. in diameter and 28 in. long, and run in babbitt and brass bearings on the bottom, composition on top.

The top roll is mechanically balanced by counterweight, and is moved up and down by $16\frac{1}{2}$-in. hardened steel screws of $2\frac{1}{2}$-in. pitch, working in bronze screw boxes and driven by two 200-hp, d-c mill type motors under adjustable voltage control. The mill is designed for a maximum roll opening of 78 in. and a maximum

← **General layout—Cleveland Works**

lift speed of 600 in. per min. Selsyn-operated dials in the pulpit indicate the roll opening.

The mill is driven directly by a twin motor drive composed of two 5000-hp, 700-v, 0/40/100-rpm shunt-wound motors. Each motor drives one roll through 22-in. diam spindles.

The drive motors draw power from a motor-generator set consisting of four 2500-kw, 700-v d-c generators, a steel plate flywheel (250,000 hp-sec stored energy at 514 rpm), and an 8000-hp, 11,000-v, 514-rpm wound-rotor induction motor.

The mill drive develops an operating torque of 1,310,000 lb-ft and a maximum torque of 2,950,000 lb-ft. It is designed so that a vertical mill can be added on the delivery side if it should be desired in the future.

On each side of the mill are side guards driven through racks and pinions by two 200-hp mill type motors. The side guards on the exit side of the mill are equipped with manipulator fingers operated through an eccentric by a 150-hp motor.

Also on each side of the mill are two feed rolls and four mill rolls, each individually driven by mill type motors operated at reduced voltage to give 17 hp at 53 rpm.

The mill table on each side of the mill is 34 ft-11 in. long and is driven through lineshaft and gears by two 200-hp mill motors.

Scale from the steel being rolled falls through the tables and is flushed down a flume below the tables to a scale pit. An overhead crane with clam shell bucket moves scale from this pit into railroad cars.

All mill auxiliaries (mill tables, feed rolls, side guards, manipulator, screwdown and shear) operate under adjustable voltage control. Power for these auxiliaires comes from two motor-generator sets. One set consists of four 200-kw and one 120-kw d-c generators driven by a 1000-hp, 2300-v, 1200-rpm synchronous motor. The other set has four 200-kw generators, one 120-kw generator and a 75-kw generator, all driven by a duplicate 1000-hp synchronous motor. One 200-kw unit serves the ingot buggy, two serve the manipulators, two serve the screwdown, two serve the front and rear mill tables, and one serves the manipulator fingers. The 120-kw generators serve the front and rear mill rolls. The 75-kw unit serves the mill runout tables. There is also a 200-kw generator driven by a 300-hp motor to be cut in as a spare wherever it may be needed.

The main drive motors, motor-generator sets, control and switchgear are housed in a motor-room provided with a down-draft recirculating ventilating system. The recirculated air passes through a traveling screen filter and air-to-water coolers. Make-up air for the system is cleaned by an electrostatic precipitator.

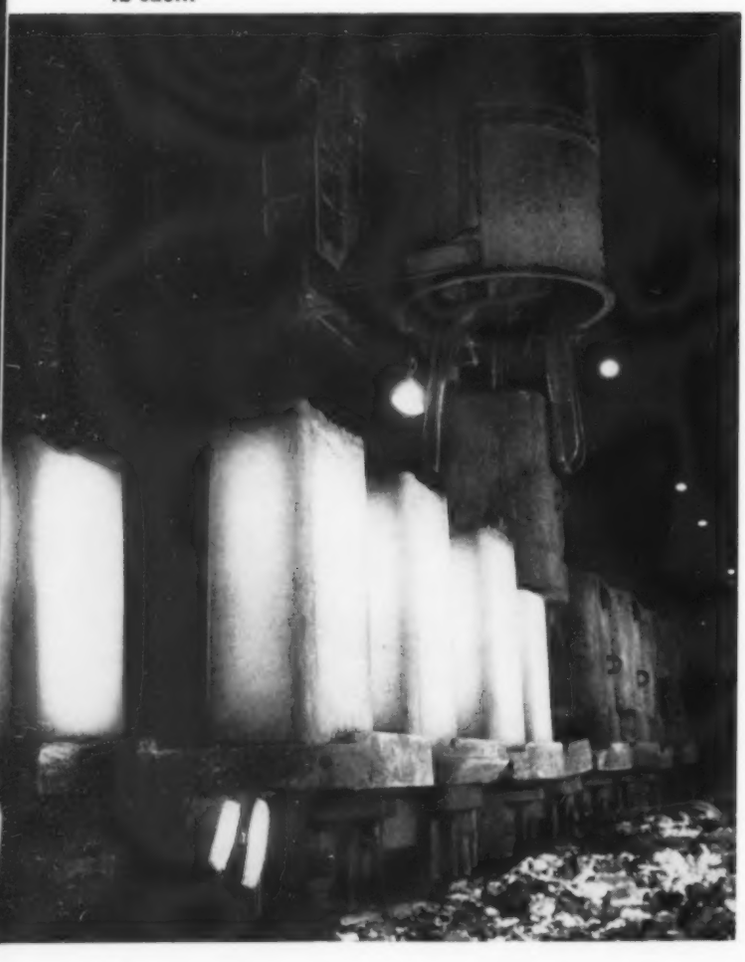
About 55 ft beyond the mill is a hot-scarfing machine which can skin all four surfaces of the slab.

The slab shear lies in a table line paralleling the mill line, and connected to it by a chain-type transfer. The shear is designed to cut hot steel slabs up to 8 in. thick x 68½ in. wide. It is driven by two 350-hp d-c mill type motors under adjustable voltage control. It is equipped with a motor-operated screw type shear gage. Crops fall below the shear and are carried by conveyor to a crop pit. They are transferred from this pit to railroad car by overhead crane with magnet.

Slabs from the shear pass to a piler and are then moved by crane to the slab yard or scarfing bed.

The mill and its auxiliaries are lubricated principally by three recirculating oil systems and five central automatic grease systems.

After ingots have solidified, they are stripped and charged, still hot, into the soaking pits. Ingots weigh up to 34,000 lb each.



STRIP MILL

The present hot strip mill is an alteration of a 77-in. mill originally put into operation in 1932 and subsequently rebuilt in 1951. The previous roughing train consisted of a scalebreaker, three separate edgers, three two-high and one four-high roughing stands. This has been replaced by a scalebreaker, one edger and a reversing roughing stand.

Cold slabs are brought from the slab yard or the scarfing bed to the strip mill by crane and rail. They are handled by magnet and overhead crane to a magazine elevator feeder, which in turn moves them on to the furnace charging table. This table, 142 ft-6 in. long, extends across the rear ends of three slab heating furnaces. At each furnace is a double pusher which can be operated as a single unit or as two separate units, depending on the length of slabs being heated. The pusher moves slabs from the charging table and through the furnace.

The furnaces have hearths 80 ft long x 19 ft-5 in. wide and are of three-zone, continuous design, rated at 100 tons per hr each. They are fired with natural gas through six burners on top and six burners on the bottom of the main heating zone, and through eight burners

This 46-in, high-lift blooming mill rolls ingots down into slabs 24 to 68½ in. wide and 4 to 8 in. thick for the hot strip mill.

overfiring the 16 ft-6 in. soaking zone. Oil can also be used as a stand-by. These burners provide total capacity for 205,000,000 Btu per hr input. Each of the three firing zones has individual controls on fuel input and fuel-air ratio. Automatic temperature controls are provided on the main heating zone, the soaking zone and on recuperator temperatures. Furnace pressure is also automatically controlled.

The furnaces are completely insulated and steel-encased. The suspended roofs are of semi-silica brick.

Two clay tile recuperators on each furnace contain 1440 sq ft of heating surface to heat air for combustion to 500 or 600 F. Air is handled by a 75,000-cfm, 9-in. water column fan for each furnace.

Slabs are usually cold when charged to the furnaces. Fuel consumption averages 1,900,000 Btu per ton of slabs heated.

The heated slabs are expelled from the furnace by action of the furnace pushers and slide down the furnace discharge chutes to the mill tables which extend 153 ft to the hot mill. Details of the mill are given in Table V.

The scalebreaker was originally a stand of the old roughing train, relocated with its drive and rebuilt for scalebreaker service.

The vertical edger is underdriven, with rolls overhung on vertical spindles driven through integral bevel and single helical gearing by individual motors.

The edger and the reversing rougher are operated in synchronism under adjustable control. The drive motors of both stands receive power from a motor-generator set consisting of four 2500-kw, 700-v d-c generators driven at 514 rpm by a 10,000-hp, 11,000-v synchronous motor. Normally, three generators in series feed the two rougher motors and one feeds edger motors, but switching is arranged so that the mill can be operated with any one generator out of service, with two then feeding the rougher motors and one feeding the edger motors.

Front and rear mill tables serving the rougher each consists of 15 rollers driven by a 50-hp mill type motor. Six feed rollers in front of the mill are driven by a 50-hp motor, as are two feed rollers in back of the mill.

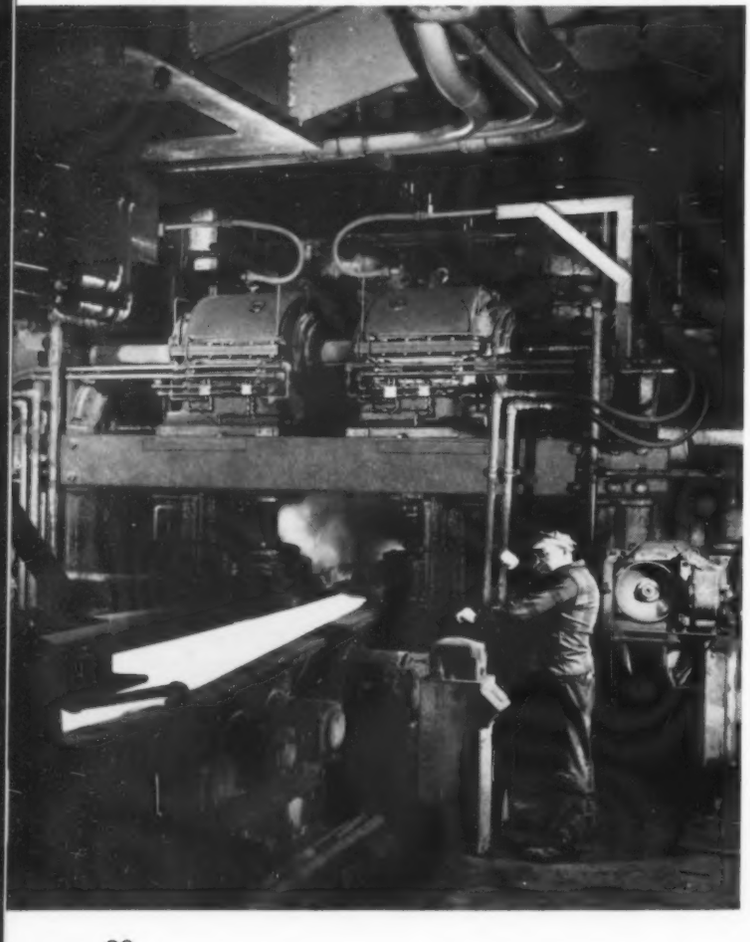
The roughing scalebreaker screws are operated by two 35-hp motors. Edger roll adjustments are effected by two 100-hp motors. Mill screws on the roughing stand are driven by two 100-hp motors. In the rougher, the top roll is hydraulically balanced through the action of a weight-loaded accumulator and plunger pump.

TABLE V
Strip Mill Data

Stand	Roll body length, in.	Roll diameter, in.		Distance from preceding stand, ft-in.	Motor data				Gear ratio	Roll, rpm	Roll face speed, fpm
		Work roll	Backup roll		Hp	Voltage	Type	Rpm			
Hot Mill											
No. 1 scalebreaker	77	33½	..	...	1600	2300	Induction	596	26.5	23	202
Edger	46¼	45	..	54-8	(2) 750	700	Shunt	90/225	3.0	30/75	353/882
Reversing rougher	80	38	54	13-7	(2) 4000	700	Shunt	40/100	Direct	40/100	397/990
No. 2 scalebreaker	77	26	..	159-9¼	100	230	Shunt	185/580	15.71	11.8/37	80/250
No. 1 finisher	77	21 7/16	46½	13-9	3500	600	Shunt	175/400	5.75	30.5/69.5	170/388
No. 2 finisher	77	21 7/16	46½	21-0	3500	600	Shunt	175/400	3.42	51/117	285/650
No. 3 finisher	77	21 7/16	46½	21-0	3500	600	Shunt	175/400	2.24	78/178	435/990
No. 4 finisher	77	21 7/16	49	21-0	3500	600	Shunt	175/400	1.59	111/251	620/1400
No. 5 finisher	77	21 7/16	49	21-0	3500	600	Shunt	175/400	1.33	132/310	738/1730
No. 6 finisher	77	21 7/16	49	21-0	2500	600	Shunt	200/500	1.32	152/379	850/2110
Tandem cold mill											
No. 1 stand	77	21	56	...	(2) 1750	750	Shunt	150/375	1.285	117/292	643/1606
No. 2 stand	77	21	56	13-7½	(2) 3000	750	Shunt	225/485	1.355	166/358	910/1970
No. 3 stand	77	21	56	13-7½	(2) 3000	750	Shunt	225/485	0.9276	243/523	1330/2880
No. 4 stand	77	21	56	13-7½	(2) 3000	750	Shunt	225/485	0.7097	317/683	1740/3760
Reel	..	24	..	13-0	1400	750	Shunt	185/650	Direct	185/650	
Temper mills											
No. 1	77	20½	49½	...	500	250	Shunt	450/900	3.48	129/258	693/1385
No. 2	56	19½	53	...	(2) 500	600	Shunt	575/1150	1.676	343/686	1750/3480
No. 3	77	33	..	...	375	230	Shunt	430/860	13.2	32.6/65.2	282/565

All auxiliary drives on the roughing stand (mill tables, feed rollers, screw-down and runout table) are driven under adjustable voltage control, drawing power from three 900-hp synchronous motor-generator sets. One of these sets has two 150-kw generators for the approach table and four 100-kw generators for screwdowns and edger roll adjustment. Another set has two 350-kw generators for mill tables and feed rollers of the roughing stand, and one 100-kw generator serving the scalebreaker drive. The third set has two 300-kw generators which feed the rougher runout tables.

This vertical edger, located 13 ft-7 in. ahead of the reversing rougher, is operated in synchronism with the rougher.



The entire roughing mill usually operates under punch-card programming control. Mill and table directions and speeds, as well as mill and edger openings, draft compensation and hydraulic sprays, are programmed on a punch-card for up to nine passes. This card is inserted in a card reader and when the schedule advance button is pushed, the reader transfers data from the card to the programming equipment. When the pass advance button is pushed, the mill is set for first pass operation. Screws on the scalebreaker, edger and rougher are set to the proper opening. Scalebreaker, edger, rougher and mill tables run forward at the programmed speeds, allowing for the draft taken in the mill. Side guides are properly positioned. As the slab goes through the mill, hot metal detectors actuate hydraulic sprays and deceleration, and set the programming for the second pass in the opposite direction. When the last pass called for on the program is completed, all functions return to their initial settings.

In addition to complete automatic operation, the mill can be operated manually or semi-automatically, in which the operator must push a button to initiate the next pass or in which only the screw settings are programmed.

From the roughing stand, the steel proceeds over a delay table to a crop shear and the finishing train about 160 ft away.

The finishing train, consisting of a two-high scalebreaker and six four-high finishing stands, served the original mill, but has been speeded up somewhat and provided with modern controls. Also, an old roughing stand was rebuilt, relocated and provided with new gear drive, pinions and motor to act as the finishing scalebreaker. Maximum delivery speed of the mill is now 2080 fpm, 25 per cent higher than the old 1660 fpm.

The 38-in. and 54-in. x 80-in. reversing rougher is arranged for automatic operation, with a punch-card programming control system, which also controls the vertical edger.

The finishing stands are driven by d-c shunt motors under adjustable voltage control. These motors receive power from three motor-generator sets of the following characteristics:

Two duplicate sets each consisting of two 2000-kw, 600-v d-c generators, one 150-kw exciter and one 5800-hp 11,000-v, 514-rpm synchronous motor.

One set composed of two 3000-kw, 600-v, d-c generators and an 8400-hp, 11,000-v, 360-rpm synchronous motor.

Between the finishing stands are five pneumatically-actuated loopers to take up slack in the strip between successive stands.

Two 35-hp motors operate the screwdown on the finishing scalebreaker, while two 30-hp motors are used on each finishing stand. Magnetic clutches are used in these screwdown mechanisms, so that the motors of any stand may be operated separately or in unison.

In the roughing train, babbitted bearings are installed for the roll necks of the scalebreaker and the edger. In the reversing stand, work rolls operate in roller bearings and backup rolls run in oil-film bearings with aluminum bushings. Roller bearings are used for the necks of all rolls in the finishing train.

Leaving the finishing train, strip passes over a runout table about 340 ft long to two mandrel-type coilers. The runout consists of 154 rollers individually driven under variable frequency control. The coilers form coils of 28 in. I.D. and up to 58 in. O.D. Each coiler mandrel is driven by a 200-hp d-c motor. Coiler motors draw power from two motor-generator sets, each consisting of a 200-kw, 250-v d-c generator driven by a 300-hp, 440-v, 1200-rpm motor.

Radiation pyrometers are installed to record strip temperatures at the delay table, at the last finishing stand and at the coilers.

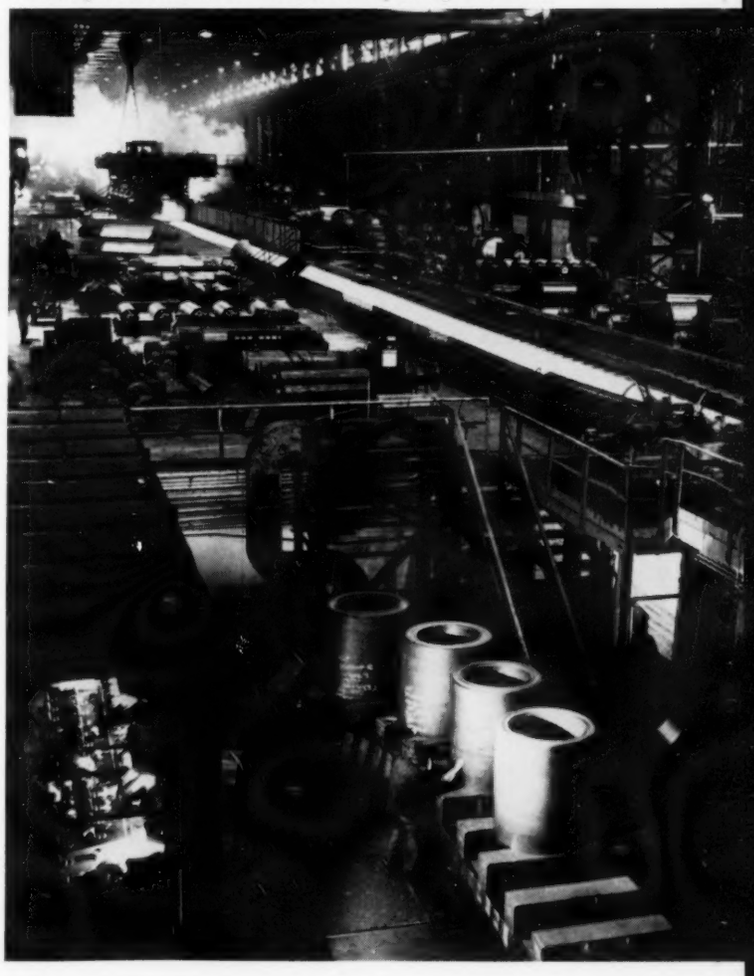
To aid in producing good surface on the strip, hydraulic descaling sprays are installed on the top of No.1 scalebreaker, on top and bottom of the delivery side of the reversing rougher, on top and bottom of No. 2 scalebreaker, and on the top of the delivery side of No. 1 finisher. Valves on these sprays are controlled through solenoids. Water for these sprays is supplied by three 1200-gpm, 1200-psi, six-stage centrifugal pumps. There are also steam jets at the entry side of the reversing rougher to blow loose scale from the slab.

Main drive motors, motor-generator sets, control equipment and swtichgear for the hot strip mill are located in an enlarged motor room. The roughing end of the motor room has a down-draft recirculating system to cool rotating equipment. This system has an air filter, an electrostatic preciptator and an air-to-water heat exchanger. The finishing end of the motor room is supplied with ventilation from two 100,000-cfm and two 30,000-cfm fans which take air through air filters, pass it up through the finishing train motors and down through the finishing train motor-generator sets.

The hot strip mill is lubricated by five recirculating oil systems and five central automatic grease systems.

The hot mill is designed to reduce slabs ranging 24 to 68½ in. wide, 4 to 8 in. thick, 75 to 214 in. long, and 7000 to 20,000 lb in weight. Product may range between 24 in. and 72 in. wide in gages down to No. 12. The mill can go down to No. 14 gage in widths up to 61 in., to No. 16 gage in widths up to 49 in., and to No. 18 gage in widths up to 37 in. Finished gages average between No. 10 and No. 12 gage. A monthly production of

This view shows the coiling end of the strip mill, with the finishing train at upper left. Runout table rollers are individually driven under variable frequency control.



Two continuous pickling lines (80 in. and 56 in. respectively) clean the hot rolled strip prior to cold finishing.

136,700 net tons is projected, with slightly more than half going on to full finished, cold reduced product.

HOT FINISHING

Hot finishing facilities include two new shearing lines. One of these cuts coil stock 0.048 to 0.25 in. thick and 18 to 74 in. wide into lengths of 24 to 288 in. as desired, or it may be used to temper roll coil stock. This line includes an uncoiler, crop shear, side trimmer, entry tension bridle, temper mill, exit tension bridle, recoil mandrel, flying rocker-type shear, roller levelers, oiler, pinch rolls and piler. The temper mill is the 33-in. x 77-in. two-high unit listed in Table V.

This line operates at speeds up to 350 fpm and is expected to handle about 50 tons per hr.

The other line handles coiled stock up to 0.375in. thick and 24 to 74 in. wide, cutting it into lengths of 48 to 500 in. This line includes an uncoiler, looping table, pinch rolls, side trimmer, scrap chopper, looping table, pinch rolls, upcut shear, roller leveler, pinch rolls and piler. It operates at speeds up to 140 fpm and is expected to process about 25 tons per hr.

PICKLING

All cold finishing equipment is located in a group of buildings to which hot rolled coils are taken by tractor-trailer.

Hot rolled stock intended for cold reduction is taken to one of two continuous pickling lines, one rated 80 in., the other (a new unit) 56 in.

Both lines are about 700 ft long overall and each contains four acid solution tanks, a spray tank and a water tank. All tanks are constructed of steel plate and are lined with rubber and three courses of brick laid up in acid-resisting cement. Acid tanks in the 80-in. line are 82 ft long x 8 ft-2 in. wide x 5 ft-1 in. deep and normally hold 18,790 gal of solution. The spray tank is 9 ft long and the water tank 25 ft. This line operates at speeds up to 375 fpm.

In the 56-in. line, acid tanks are 82 to 86 ft long x 6 ft-11¼ in. wide x 5 ft-1 in. deep, and hold 13,750 to 14,420 gal. The spray tank is 13 ft long and the water tank 23 ft. Line speed ranges up to 500 fpm.

All tanks have steel plate, rubber-lined covers which are vented to a collector fan.

Pickling solutions range from 7 to 20 per cent sulphuric acid and are kept at 200 to 205 F by automatically controlled steam jets.

The pickling department is expected to process somewhat more than 83,000 net tons of strip per month.

COLD MILL

Another new unit in the modernization program is a 77-in. four-stand tandem cold reduction mill, designed to reduce pickled strip 24 to 72 in. wide from gages of 0.08 to 0.165 in. down to 0.0149 to 0.1046 in. Coils 24-in. I.D. are handled in outside diameters of 34 to 72 in., widths of 24 to 72 in., and weights up to 60,000 lb. Some details of this mill are given in Table V. The projected rolling rate of this unit is 150 tons per hr.

Mill housings, of cast steel, are one-piece, closed top type, each post having a cross-sectional area of 952 sq in. Housings are tied together with a one-piece, box type steel cross tie at the top and steel separators bolted between the housing feet at the bottom.

Work rolls of forged alloy steel run in roller bearings. Backup rolls of cast alloy steel operate in oil-film bearings which will withstand a mill separating force of 6,000,000 lb. Hydraulic cylinders in the bottom chocks balance the top chocks and rolls. One oil-hydraulic system serves all four stands of the mill.

Top rolls are moved up and down by forged steel screws 18 in. in diameter, four threads per inch. The screws on each stand are driven through combination triple reduction helical and worm gearing by two 100-hp d-c mill type motors. A magnetic clutch permits operation of the screws independently or in unison.

Each stand is driven through a dual gear drive. Each work roll is driven by its individual motor, with no mechanical connection between the rolls.

Roll coolant, a mixture of soluble oil and water, is supplied by a 2500-gpm system operating at 150-psi pressure. Spray headers mounted on the mill guides deliver the coolant to the mill.

A fog exhaust system of about 100,000-cfm capacity is provided for the mill stands and reel. It is a downdraft type with collector tunnels in the mill foundation. Fog is moved by an exhaust fan and passes through a fog eliminator and a 70-ft exhaust stack.

The tension reel provides a maximum pull of 12,000

The four-stand 21-in. and 56-in. x 77-in. cold reduction mill, with total drive power of 22,900 hp, has a top delivery speed of 3760 fpm.

lb. It is designed with four segments which provide a true circle with no openings except the jaw when expanded. When collapsed, all segments move radially toward the center. A horizontal belt wrapper serves to start the leading end of the strip on the reel.

A conveyor and an upender moves coils from the reel a two-strand chain conveyor about 100 ft long, which carries coils to an adjacent annealing department.

X-ray gaging equipment is installed at the exit sides of No. 1 and No. 4 stands. It adjusts main drive speeds on the first three stands to maintain uniform strip gage. Additional equipment is being considered to adjust screwdown settings for the same purpose.

The main drive motors operate under adjustable voltage control with rotating and static regulators. Power is drawn from two motor-generator sets, each driven by a 13,500-hp, 11,000-v, 514-rpm synchronous motor. One set carries two 1400-kw generators serving No. 1 stand drive, two 2400-kw generators for No. 2 stand drive, one 1200-kw generator for the tension reel, and a 150-kw exciter. The second set has four 2400-kw generators serving the third and fourth stand drives. The principal generators are 750 v. Each serves an individual drive motor.

The cold mill and its auxiliaries are lubricated by four recirculating oil systems and one central automatic grease system.

ANNEALING

After cold reduction, the strip must be annealed to remove strains, obtain proper grain structure, soften the steel and increase ductility. This is done in three separate annealing bays.

Department No. 1 consists of 15 rectangular portable cover furnaces and 40 bases. The furnaces are 436 in. long x 98 in. wide, with a piling height of 166 in. They accommodate four stacks of coils, with charges averaging 200 tons per furnace.

No. 2 department contains three rectangular cover furnaces 220 in. long x 78 in. wide, with piling heights of 140 in. and nine single stack circular covers, 72 in. in diameter x 156 in. high. The rectangular furnaces take charges of 150 tons, the circular furnaces, 52 tons.

No. 3 department contains 11 rectangular cover furnaces and 30 bases, duplicating those in No. 2 department.

All of these annealing furnaces are heated by radiant tubes in which natural gas is burned under automatic temperature control.

After cold reduction, strip is annealed to remove strains. There are 29 rectangular portable cover furnaces, as shown here, and nine single stack cylindrical covers.

Coils are annealed at temperatures of 1260 to 1280 F. Typical cycles run about 26 hr heating, 6 to 25 hr soaking and 80 hr cooling. Fuel consumption averages 1,000,000 to 1,200,000 Btu per ton.

To prevent oxidation of the steel surface while annealing, inert atmosphere is supplied by six gas preparation machines, three rated at 20,000 cfhr each, two at 10,000 cfhr each and one at 8000 cfhr.

TEMPER MILLS

After annealing, strip is given a light skin pass to improve strip surface and restore the desired stiffness and hardness. There are three temper mills, one of which is a part of the recent modernization program. This unit is a single-stand four-high mill, 19½ in. and 53 in. x 56 in. It will handle coils of 24 in. I.D. up to 72 in. O.D., with widths ranging 24 to 52 in. and weights up to 52,000 lb. A rolling rate of 75 tons per hr is expected.

Roll neck bearings are roller on the work rolls and oil-film on backup rolls. Mill screws are 18 in. in diameter, four threads per inch. Two 50-hp mill type motors operate the screwdown.

Each work roll is individually driven by one of the 500-hp drive motors which work through a dual-reduction gear unit. There is no mechanical connection between the two rolls.

The mandrel type pay-off reel is driven by a 300-kw, 300/1200-rpm d-c drag generator which can exert back tension up to 3800 lb.

The tension reel is driven by a 1200-hp 300/1050-rpm double-armature d-c motor. Tension up to 11,200 lb is available.

A double cut shear is mounted between the mill housings on the delivery side.

Some details of this mill, as well as of the previously existing 20½ in. and 49½ in. x 77-in. four-high mill and 33 in. x 77-in. two-high mill, are given in Table V.

The 56-in. mill is served by a motor-generator set consisting of an 800-kw, 600-v generator for the mill drive motors, a 300-kw, 600-v unit for the pay-off reel, a 960-kw, 600-v unit for the tension reel and a 50-kw exciter, all driven by a 2600-hp, 11,000-v, 720-rpm synchronous motor.

Cold-rolled product to be cut into lengths may be put through two shear lines. One of these cuts material 24 to 48 in. wide and 0.025 to 0.06 in. thick into lengths of 30 to 180 in. This line contains a processor, pay-off reel, rotary shear, leveler, oiler, piler and scale. It operates at speeds up to 800 fpm and will handle about 35 tons per hr.

The second line cuts material 22 to 74 in. wide and 0.02 to 0.0937 in. thick into lengths of 30 to 192 in. This unit has an entry mandrel, pinch rolls, rocker type shear, leveling rolls and oiler. It runs at speeds up to 30 fpm and processes about 25 tons per hr.

There is also a 48-in. slitter which can handle strip 24 to 48 in. wide and 0.015 to 0.146 in. thick at speeds up to 1000 fpm.

Now under way is a program which will enlarge warehouse and shipping areas in the finishing division.

SERVICES

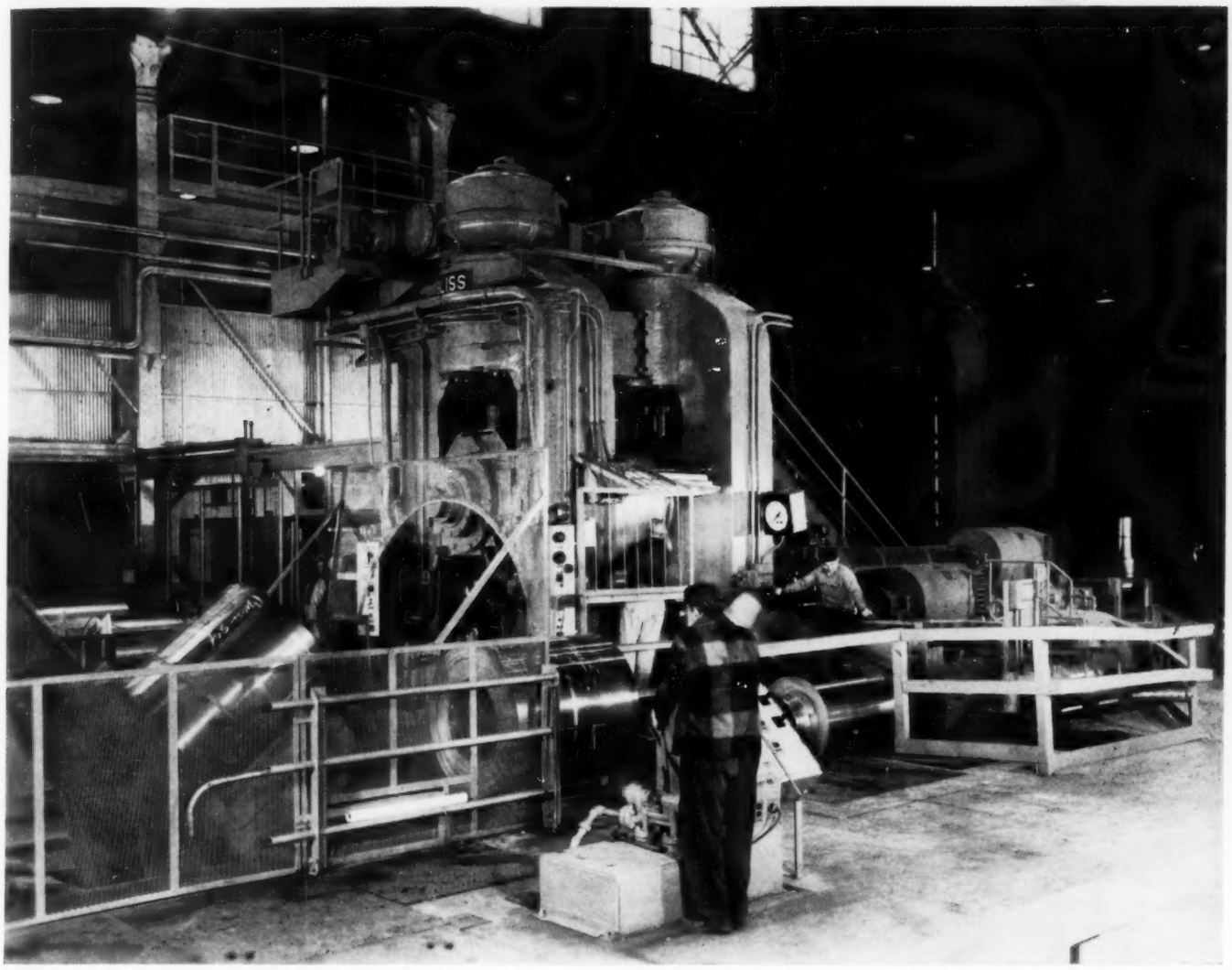
The metallurgical department is primarily concerned with quality control. Metallurgical contact engineers investigate the customer's requirements and act as a liaison between the consumer and the mill. Metallurgical features determined by this contact are then entered on mill orders by specification personnel.

Metallurgical representatives at the blast furnace, steel works, hot rolling and cold reduction departments serve to maintain steelmaking and product quality standards. Yield improvement and plant-level development are other areas of endeavor carried on by a full complement of metallurgical investigators and technicians. I.B.M. statistical control procedures are used for analysis of steelmaking, rolling and product inspection data. Inspection of finished product is the function of a separate division answering to the works manager's office.

Full coverage of the chemistry of raw materials, material in process and finished product is under the control of a chemical services division in a modern laboratory which includes a direct-reading spectrograph.

The Cleveland plant operates on both 60-cycle and 25-cycle power, with no connection or interchange between the two systems. At present all principal drives operate on 60 cycles, with 25-cycle power for pumps, air compressors and auxiliaires.

Sixty-cycle power is provided by the utility company serving the area. It is transmitted at 132,000 v to two



This 19½ in. and 53-in. x 56-in. temper mill, a unit in the modernization program, is driven by two 500-hp motors at speeds up to 3480 fpm.

90,000-kva transformers, each with one 50,000-kva, 11,000-v winding and one 50,000-kva, 22,000-v winding on the secondary. The 22,000-v lines run underground to the electric furnace plant. The 11,000-v lines run underground to the steel company's main station, from where power is distributed (principally underground) to various load centers in the plant. Principal 11,000-v centers are the slabbing mill motor room, hot strip motor room, blast furnace power house, open hearth substation, tandem mill motor room, and finishing department substation.

Power generated within the plant comes from two 10,000-kva, 6600-v, 3-phase, 25-cycle turbogenerators located in the blast furnace power house. One unit is equipped with a barometric condenser, the other with a low level jet condenser. Steam consumption averages about 15 lb per kwhr. The 25-cycle power is distributed over underground lines to the blooming mill motor room, the strip mill substation, two pump houses and other auxiliary centers.

Excluding the electric furnaces, the plant, with normal operations, uses about 16,600,000 kwhr per month. About 13,000,000 kwhr of this is purchased, with a 30-min demand of 35,000 kva. The remainder is generated for the 25-cycle system.

At the various load centers, some 11,000-volt, 60-cycle power is stepped down to 4160-v, 2300 v or 480 v for auxiliary usage. Some 6600-v, 25-cycle power is

TABLE VI
Boiler Characteristics

No. of boilers	4	2	1	1	2
Rating, hp	834	822	1108	1337	1530
Fuel	Blast furnace gas and pulverized coal	Blast furnace gas and pulverized coal	Pulverized coal	Blast furnace gas and pulverized coal	Blast furnace gas
Heating surface, sq ft	8340	8226	11,083	13,375	15,307
Water wall surface, sq ft	...	...	1234	...	2304
Air preheater surface, sq ft	...	...	...	7920	14,880
Combustion volume, cu ft	4750	4700	6300	7611	8780
Usual per cent of rating	150	150	250	200	200
Efficiency, per cent	67	67	78	75	71

In the foreground are the buildings housing the cold reduction and finishing departments. The steel plant and blast furnaces are at upper center.

stepped down to 2300 v or 230 v.

Direct current is supplied by two 1000-kw rectifiers at the slabbing mill, one 1500-kw rectifier at the open hearth and one 1000-kw rectifier at the blast furnace, all operating from the 60-cycle system. Operating from the 25-cycle system are two 1500-kw rotary converters and two 1000-kw motor generators at cold mill substations, a 1500-kw motor-generator set at the slabbing mill and a 1000-kw motor generator at the blast furnace.

Steam for power generation and for process work and heating throughout the plant is supplied by ten boilers located in two adjacent buildings in the blast furnace area. These boilers operate on a common header at 250 psi pressure, 150 F superheat. All are of bent tube design. Their characteristics are given in Table VI.

Service water is supplied from three pump houses. In the blast furnace area, one house containing eight pumps pulls about 50,000 gpm from a gravity intake near the river. At the steel works another house containing six pumps takes about 55,000 gpm from the river. A small station at the finishing area produces about 300 gpm. All together, these pumping stations provide about 110,000,000 gal per day.

In addition, about 5,000,000 gal of purchased water are used per day. Some of this is used (with an internal chemical treatment) for boiler feed.

A central oxygen plant, rated at 48,000,000 cu ft per month, produces high purity oxygen for use in the open hearth, scarfing and miscellaneous applications throughout the plant.

Compressed air is supplied from motor-driven compressors located in load centers at the blast furnace, steel works and finishing divisions.

In addition to the 39,000 tons of coking coal, the Cleveland Works, with full operations, uses about 3,300,000 gal of fuel oil, 450,000,000 cu ft of natural gas and 3000 tons of steam coal per month. As previously mentioned, fuel oil is received through a pipeline from a nearby refinery and another line from the river docks. Natural gas comes from the utility supplying the district at 50 to 60 psi pressure. This pressure is reduced to the desired levels at the various consuming centers. Steam coal comes to the plant by rail.

About 38 miles of standard gage railroad track lie within the plant, of which about two-thirds belong to the steel company and one-third to the Cuyahoga Valley Railroad Co., a subsidiary company. All locomotive equipment is owned by the subsidiary. Tractor-trailers and trucks are also used extensively for intra-plant transportation.

Plant maintenance is supported by the usual complement of shops, including mason, carpenter, blacksmith, machine, pipe, rigger, boiler, electrical, welding and mobile equipment repair. There are also two roll shops (one at the steelworks division, one at the finishing division) and a roll grinder at the tandem cold mill. ▲

by C. H. Zweifel, Chief Engineer, Pacific Coast Engineering Co., Alameda, Calif.

A New Concept In Crane Control

. . . . d-c control provides, for a single hook, light load speeds up to four times rated load speeds . . . . for light loads, up to twenty per cent load, the operator can select one of three speeds above motor base speed . . . . control prevents the operator from mistakenly operating a heavily loaded hook at light load speeds . . . . speed regulation is less than five per cent for all master switch positions . . . .

EXISTING forms of available crane control leave much to be desired from a functional and operational standpoint, whether of the basic a-c or d-c type. With the operational requirements of crane users in mind, the crane control system described in this paper was developed and perfected so that it is adaptable either to a prime a-c or d-c source.

The inherent characteristics of the d-c adjustable voltage system have long represented the ideal characteristics for crane control. This system furnishes controlled acceleration during hoisting due to the characteristics of the d-c machine. It furnishes high speed light hook hoisting of approximately 150 to 200 per cent of base motor speed when used with d-c motor; and, most important, in the lowering cycle this system furnishes stable lowering control with the inherent regenerative and dynamic braking characteristics of the d-c motor. The basic system provides stable lowering speeds both at high speeds and reasonably low speeds within the capacity of the rotating equipment. Electrical suppliers and designers have for some time been developing and currently have on the market crane control systems that are designed to simulate the operation of the d-c variable voltage system. These control systems are unnecessarily complicated by the use of regulating exciters eddy current brakes and load indicating devices or fragile vacuum tube systems, which result in excess maintenance due to severity of operational requirements. All of these schemes incorporate additional components in order to produce the results required. The use of additional devices complicates the power and control circuitry in the crane system and results in higher first cost, higher maintenance cost, and more frequent loss of crane operating hours.

In addition to simplifying the control circuitry, it was felt to be to the advantage of crane users to have a piece of equipment that could serve in a dual capacity. In general, cranes are purchased with a specific load handling requirement in mind. The required electrical equipment of the crane is dictated by load handling and speed requirements. Ideals of operations are often compromised in order that the motor horsepower demand is not excessive. In a great many instances the crane is required to do many other miscellaneous jobs in the shop for which the load is considerably less than the rated capacity of the crane. Crane users have been buying cranes with a main hoist designed specifically to handle the major job at hand and an auxiliary hoist of smaller capacity and higher speed to do the miscellaneous work. The crane control system described herein consolidates these two functions into one set of hoist equipment, i.e., one motor, one controller and one mechanical drive that provides both a heavy hook capacity operating at low speed and a light hook capacity operating at high speed. The current limitations of the system are a heavy-to-light hook capacity ratio of 5 to 1 and a speed ratio of 4 to 1. For example, the system will permit operation at 50-ton and 10-ton capacities at speeds of 20 and 80 fpm respectively with one set of equipment. This limitation is imposed by the physical ability of the hoist motor to withstand the centrifugal force of 400 per cent base motor speed.

These operational characteristics established the criteria for development of this system, basically that

the unit have the desirable characteristics of the variable voltage system with the stability and braking characteristics associated with this system. Secondly, the crane should function to meet the operator's requirements insofar as load and speed are concerned. Thirdly, the unit must be of rugged, simple straightforward circuitry without fancy devices that fail frequently or require excessive maintenance.

Figure 1 shows the speed torque characteristics of the dual torque crane control system. The curves shown are for a speed ratio of four to one as described in the preceding paragraph. Speed ratios from 1¼:1 to 4:1 may be furnished. The author wishes to point out that the droop characteristics at any speed point in the full range, from empty hook to rated capacity, is limited to approximately 5 per cent. The curves shown in Figure 1 are not theoretical but represent actual test data taken from a 25/5-ton crane installed in our machine shop. It was built for the purpose of perfecting this design. The curves show speed points plotted for various loads within each load capacity. Some of the advantages shown by the speed-load characteristics noted in Figure 1 are:

1. Speed on any control point, regardless of whether the operator is working with the light hook or the heavy hook in either the hoisting or lowering direction, is basically the same irrespective of load. The operator need make no mental or physical adjustment in his operation of the crane to compensate for the load being handled.

2. When empty hook spotting is required, as when approaching the load or removing the hook to clear the area, the operator can run the crane at 400 per cent speed on the light hook to make a substantial time saving for the operation. For example, if the 50-ton

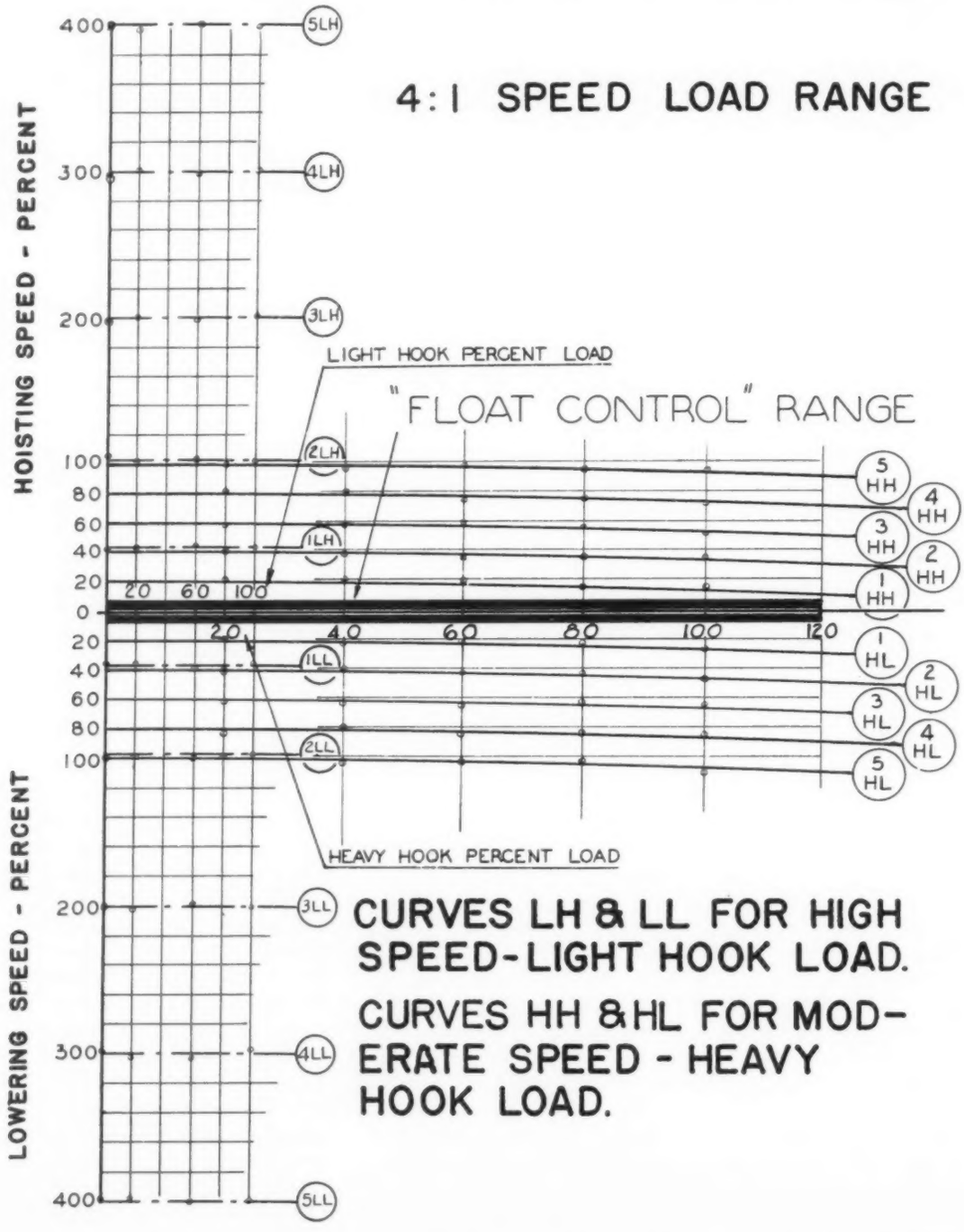


Figure 1 — These speed-torque curves for the various master switch positions were drawn from actual test data.

crane previously described is brought into position to handle a 50-ton load requiring a 40-ft lift, the empty hook approach made at high speed requires ½ min instead of the two min required at normal speed. The lift and release is made at normal speed, and the hook removal is made at high speed resulting in 37½ per cent time saving for this simple operation.

3. There are five speed control points, which is fairly standard, within each load range. However, when handling a load within the capacity of the light hook the operator has the option of switching to the heavy hook control for accurate spotting. When handling the load on the low speed point of the heavy hook, he is operating at approximately 4 per cent of the maximum rated speed of the light hook. This permits very precise handling of the load whether in the light or heavy hook range.

The basic components, incorporated in the circuit to accomplish the results shown in Figure 1, are in the simplified schematic diagram of Figure 2. These components are:

1. A d-c generator powered from either an a-c or d-c prime source.
2. A d-c hoist motor which is a constant horsepower, variable speed, stabilized shunt-wound machine with a standard d-c magnetic, shoe brake.
3. A magnetic amplifier speed regulator.
4. Motor and generator field resistors.
5. Separate independent magnetic master switches for heavy hook and light hook control (not shown in this diagram for clarity but represented by variable resistors R-11 and R-7, R-8 and R-9).

Variable voltage for variable speed operation of the d-c hoist motor is provided by the d-c generator. The output voltage of the generator is controlled by regulating the voltage applied to the generator shunt field, i.e., the higher the generator field voltage, the higher the generator output voltage. The hoist motor is a stabilized shunt machine whose speed is proportional to the applied voltage. The dual speed range, as outlined, with only one hoist motor is achieved by shunt field weakening the hoist motor in the light load range.

To understand the operation of this equipment, it is necessary to understand the operational characteristics of the magnetic amplifier SR. The magnetic amplifier is a static device which consists of a magnetic core wound with power and control windings, and dry type selenium or silicone diode rectifiers. The magnetic amplifier is a rugged device that is unaffected by the vibration present in all crane operations. When an a-c input is applied to the magnetic amplifier, it presents a varying impedance or resistance to current flow. When used where only a d-c source is available, the magnetic amplifier requires a small a-c alternator for operation. The magnetic amplifier used in this equipment has the following standard windings:

1. Power windings marked 1–2 and 3–4.
2. Control winding marked 5–6.
3. Load compensation winding marked 7–8.
4. Anti-hunt winding marked 9–10.
5. Bias winding marked 11–12.

Standard polarity on the above windings is such that a positive voltage or signal on the odd numbered terminals (1, 3, 5, 7, 9 or 11) will increase the output voltage of the magnetic amplifier. The magnetic amplifier used in this application is the self-saturating type.

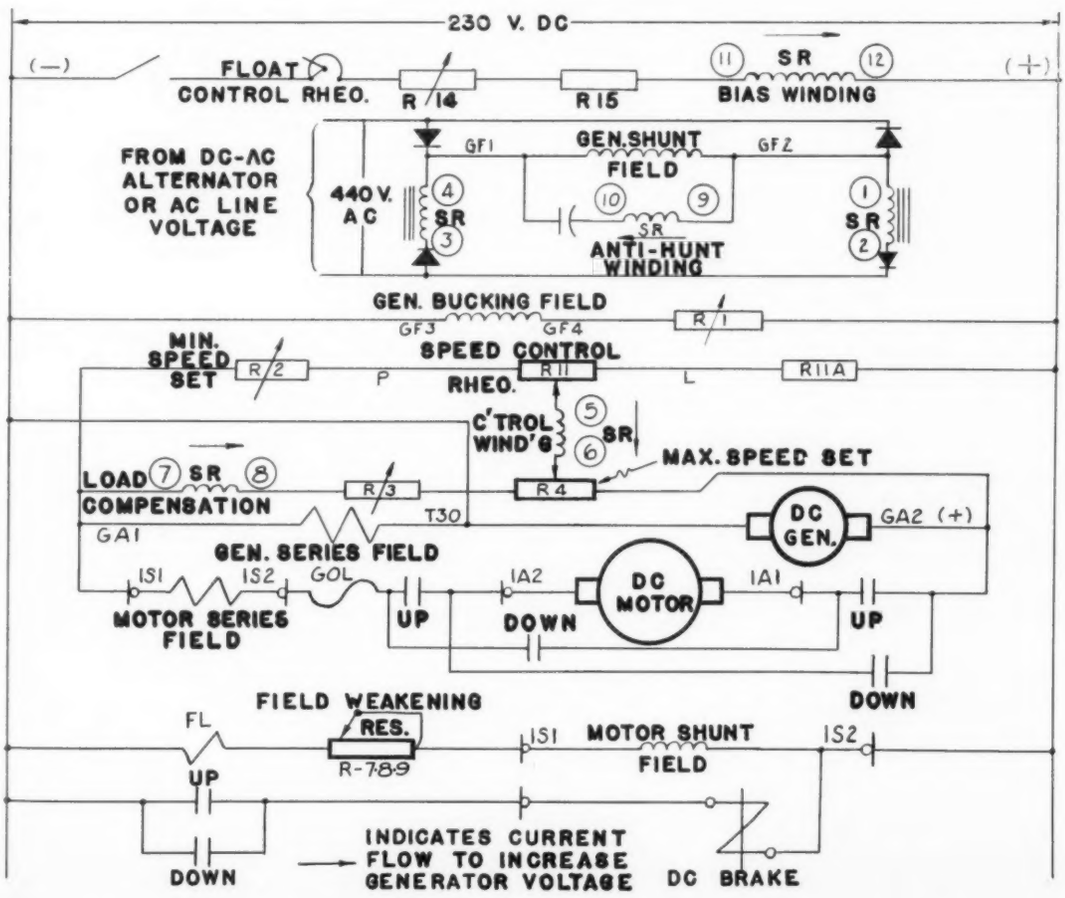


Figure 2 — Simplified power circuit for dual torque operation.

Increase in saturation in the magnetic amplifier reduces its impedance to alternating current, and thus increases the output voltage. The magnetic amplifier is basically used in the circuit as a voltage regulator to keep the motor operating at a predetermined speed regardless of load. This prevents objectionable droop in the speed-load curves shown in Figure 1.

Now let us examine the detailed operation of the circuit. Assume that the heavy hook master switch or speed control potentiometer R-11 is at point P. The positive voltage at GA2 causes a current to flow through maximum speed set resistor R-4, control winding 6-5, and minimum speed set resistor R-1 to GA1. This current reduces the self-saturating effect of the power windings and results in a minimum output from the magnetic amplifier which, in turn, results in minimum generator voltage. Concurrently another voltage is present trying to cause a current of opposite polarity in the control winding. This current flows from the positive 230-v reference source through R-11A, R-11, control winding 5-6 resistor R-4 to the negative bus of the reference source. Because of the setting of the speed control potentiometer R-11 at point P, this voltage has much less effect than the first mentioned voltage. However, as the adjustment on R-11 is moved from P towards L by manipulation of the master switch, the second mentioned voltage reduces the current in control winding 5–6 and then reverses this current. The current flow through winding 5–6 is aiding the saturation of the magnetic amplifier. At maximum saturation maximum output voltage from the generator is obtained. A speed control potentiometer, R-11 is shown with manual adjustment for simplifying purposes. In practice this is accomplished by shorting contacts that are actuated by the master control switch which varies the amount of speed control potentiometer resistance from maximum to minimum. The above covers the basic operation of the d-c hoist motor up to its base speed and full voltage. This is the variable speed operation of the heavy hook through its full range of operation. Voltage taps on speed control potentiometer R-11 may be selected almost without limitation to give desired speeds up to motor base speed.

Light hook high speed operation is achieved as follows. In general, the first and second speed points for light hook operation utilize the second and fifth speed points of the heavy hook operation. This is accomplished by relays actuated by the light hook master switch. They select the same speed control potentiometer settings on resistor R-11 as the second and fifth speed points of the heavy hook master switch do. This results in the first two speed points and brings the light hook up to rated motor speed. Speeds up to 400 per cent of motor base speed are accomplished by inserting additional resistance (R-7-8-9) in the motor shunt field. This weakens the stabilized shunt field of the motor and permits overspeed of the unit. This is accomplished through relays which, when selected by the light hook master switch, insert precalculated amounts of resistance in the motor shunt field permitting overspeeding of the unit.

When operating up to base speed the dual torque crane control motor is a constant torque device. However, when shunt field weakening is used for speeds above base speed, constant horsepower characteristics are obtained. Direction of rotation of the hoist motor is controlled by reversing the power to the motor armature with contactors U1, U2, and D1, D2. The balance of the control circuit operates identically whether hoisting or lowering.

The above discussion covers the basic operation but additional refinements are included. Winding 7–8, the load compensation winding, is connected across the generator series field. With no load on the generator (no armature current) there is no voltage across this winding. As increasing heavier loads are lifted, more armature current flows and the voltage across winding 7–8 is increased. The polarity of this voltage is positive at 7. Therefore, increasing loads increase the saturating current through winding 7–8 which, in turn, increases the magnetic amplifier output and the generator voltage. This compensates for the losses in the motor generator loop circuit and keeps the hoist speed constant regardless of changing load. Resistor R-3 governs the current flow and thus the load compensation furnished by winding 7–8. In addition, a stabilizing circuit with anti-hunt winding 9–10 is connected across the generator shunt field. This winding responds only to changes in magnetic amplifier output voltage. The polarity is such that an increase in magnetic amplifier output voltage causes desaturating current in winding 9–10. The result is a damping effect that prevents the magnetic amplifier output voltage from hunting, which would vary the hoist speed sharply by causing the generator voltage to fluctuate. Power windings 1–2 and 3–4 are connected in parallel in such a manner that the impedance of these windings varies with core saturation thus controlling the amount of generator shunt field current. The bias winding 11–12 is not pertinent to the basic operation through the dual range of the equipment. It is a winding added for the benefit of float control which will be described later in this paper. This bias winding is in parallel with control winding 5–6 for the purpose of providing additional control of the magnetic amplifier output voltage.

Several protective devices have been omitted from the circuit which is simplified for clarity. These are standard devices, which may be incorporated in any d-c system, to furnish the following protective features:

1. Hoist limit switch protection is, of course, furnished either of the pilot circuit type or of the Youngstown power circuit type with or without dynamic braking.

2. A plugging relay is provided across the motor armature terminals. It is set to pick up on the second point voltage hoisting and lowering in the main load capacity and is set to open on the first point voltage. It prevents reversing power to the motor armature until the voltage difference between the motor and generator has been reduced to a safe value so as to prevent flashover on the hoist motor commutator. It also provides regenerative braking when the master switch is returned to the "Off" position by keeping the loop circuit closed until the generator voltage has reached a low value. This is a material aid in reducing wear on the hoist motor magnet brake.

3. In order to prevent too rapid an acceleration or deceleration when working in the light hook or field weakening range, a vibrating type accelerating relay, which shorts out momentarily the field weakening re-

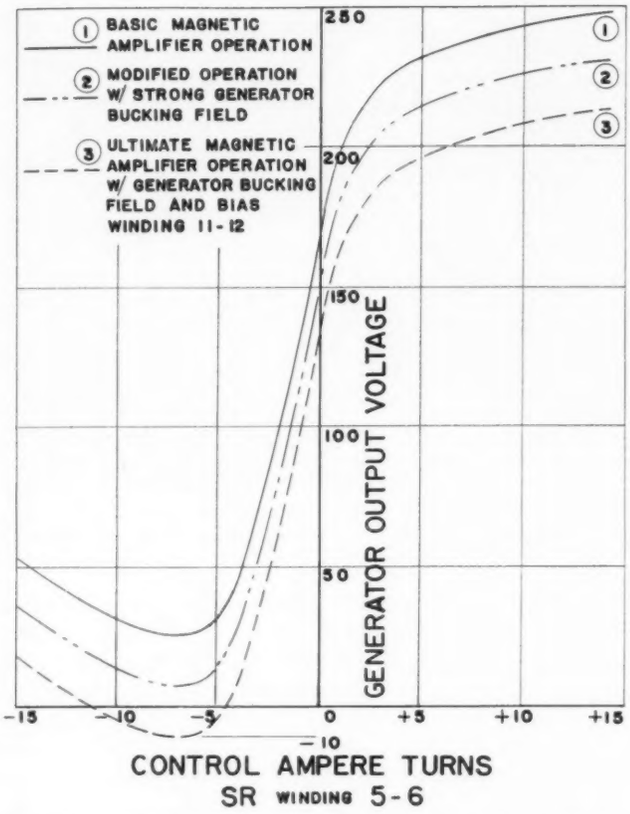


Figure 3 — This graph shows the generator output voltage for different values of control ampere-turns on the magnetic amplifier core.

sistance, governs the rate of acceleration when hoisting. In the lowering direction a similar relay inserts resistance into the motor field momentarily weakening the field and governing the rate of deceleration during regenerative lowering.

4. Load limiting current devices are provided in the loop circuit for both the heavy load capacity and the light load capacity. These current limiting relays, generally set for a 125 per cent of rated load capacity, govern the maximum load which can be handled within each load capacity. In addition, the light load current limit device is arranged in the circuit in such a manner that sufficient current must be flowing in the motor loop circuit to energize this relay before the hoist motor magnet brake can be energized for releasing. This is a double protective feature that insures having the loop circuit closed with voltage applied and current flowing prior to release of the hoist magnet brake.

One of the additional standard features of this crane control system is a device, furnished with the equipment, called float control. Float control is a means of motionlessly suspending any load from empty hook up to 125 per cent of rated crane capacity with the hoist motor brake released and the motor energized in the hoist direction but only with sufficient torque to exactly balance the load. Control of the load is completely vested in the operator by means of a float selector switch, a float rheostat and a float pushbutton. The float selector switch in the cab disconnects the main and light load master switches so that all other controls are blocked out making any large or abrupt movements of the hook impossible. The selector switch also energizes the magnetic amplifier winding 11–12, the bias winding. The float pushbutton is connected to energize the first point hoist in the heavy hook range, which provides sufficient motor torque to raise any load within the rated capacity of the crane. See Figure 1. The float rheostat is in series with the bias winding 11–12. Manual operation of the float rheostat increases or decreases the current in the bias winding thereby changing the saturation and resulting output voltage of the magnetic amplifier. The resulting generator voltage produces hoisting or overhauling (lowering) of the load in minute increments.

In order to obtain float control on dual torque it is necessary to add both a heavy bucking field on the generator and the bias winding on the magnetic amplifier. The function of these two items can be best described by referring to Figure 3.

In order for float control to work throughout the full range from empty hook to 125 per cent load, it is necessary to vary the generator output voltage from approximately 10 volts positive to 5 volts negative, negative generator output voltage being required to drive a light load down due to the inefficiency of the hoist mechanical equipment and reeving. The bucking field is therefore necessary to help reduce the generator output voltage for two reasons:

1. The magnetic amplifier itself cannot reduce the output of the generator to less than 5 per cent which is its maximum cut-off.
2. The bucking field is necessary to cancel out the generator voltage due to residual magnetism in the shunt field.

However, the magnetic amplifier is inherently a regulator. If the voltage drops due to the use of a heavy generator bucking field, the regulating characteristic of the magnetic amplifier immediately operates to increase this voltage, to that which it is trying to maintain, by means of the load compensation winding 7–8 previously described. Therefore, in Figure 3, curve 1 shows generator output voltage as a function of ampere-turns in the magnetic amplifier control winding 5–6. Curve 2 illustrates the effect of adding a bucking field to the generator. You will note that this permits regulation down to within five per cent generator output voltage. We cannot force the voltage negative merely by use of the generator bucking field because the regulating circuit is continually correcting. Curve 3, however, represents the control that can be achieved with a combination of bucking field and bias winding. The bias winding used only for the float operation provides the necessary additional ampere-turns to control generator output voltage from 10 per cent positive to 5 per cent negative. The effect of the bias winding is governed by current flow and winding saturation through the float rheostat.

It is then possible, with these components in the circuit, to float any load from zero load to full capacity and govern the motion of that load in either the hoisting or the lowering direction by controlling the generator output voltage through the float rheostat. In effect, once the load is balanced with the brake released, operation of the float rheostat increases the voltage causing hoisting or decreases the voltage a slight amount permitting the load to overhaul the motor. This feature permits accurate handling of large and expensive loads

Figure 4 — This 25/5-ton crane, installed in the machine shop of the company for which the author works, has dual torque control.

Figure 5 — This 40/20-ton gantry crane with dual torque control is installed in a utility steam generating station.

with accuracies of 0.005 to 0.010 of incremental motion. It is also to be noted that there is no energizing of the motor and releasing of the brake. Rather the unit is continually energized, so that there is no rope stretch or bounce because sudden release and arresting of the load is eliminated.

The foregoing outline basically presents the features of this equipment and points out its application and versatility in the hoisting field.

Figures 4 and 5 represent respectively two cranes which embody this crane control system and which have been in service for four years and two years respectively. Figure 4 is a 25/5-ton crane installed in our own machine shop. The heavy hook operates at 11 fpm and the light hook at 44 fpm. Figure 5 is a 40/20-ton gantry crane installed in a major utility steam generating station. The heavy hook operates at 11.5 fpm and the light hook at 21.8 fpm. Both of these units are powered from a prime 440-v, 3-phase, 60-cycle power source because this was the service available at these installations. They could, however, have been powered from a 230-v d-c or a 550-v d-c source just as well. Figure 6 shows a typical dual torque hoist panel and the arrangement of components. Note the simplicity and clearness of construction employed.

How can this crane control, with the outlined characteristics, be applied to the steel mill industry? Of course, the basic d-c system, the flat load speed characteristics, and the dynamic and regenerative braking characteristics are all suited to steel mill service and provide the operators with a basic type of control that guarantees stable operation and maximum safety. More specifically, however, there are various applications where the load requirement varies between light load and heavy load. The high speed light hook capacity in conjunction with the heavy hook low speed capacity particularly applies to steel mill usage. This characteristic results, as previously mentioned, in considerable time saving and increased production in the mill. For example, a great many installations in a steel mill require the use of a bulk material handling bucket or a lifting magnet. In these cases, the light hook high speed operation would be with the empty bucket or the unloaded magnet with load capacities from two to five tons. Full load handling capacity of these cranes is determined by the capacity of the bucket or the size of the magnet. In most instances it is from three to five times the load requirement in the unloaded condition. Increased production can be realized from faster approach and return to the work with the unloaded lifting device. This will result in more tons per hour handled by the crane, increased production, and a reduction in the cost of the finished product. Operating conditions with the loaded bucket or magnet provide the same desirable features of controlled acceleration and regenerative and dynamic braking available with present type of controls. The obvious advantage is being able to handle the light hook at speeds up to 400 per cent of full rated motor speed so as to down the approach and return time required. In comparison, a crane having a single hoist based on the rated load capacity and a maximum operating speed consistent with the rated load capacity will

Figure 6 — This dual torque hoist panel has its components in a simple, easily accessible arrangement.

require up to 50 per cent additional time expenditure per cycle.

Advantages are apparent in other mill crane applications such as warehouse, shipping room, and sorting room cranes where the load demand may vary considerably. In these installations, the load may vary widely from a few hundred pounds of material to be handled to eight or 10 tons in one lift. This necessitates selecting the crane electrical equipment for the maximum capacity. As a result, handling loads of small capacity must be done inefficiently at the lower hoisting speed. The user must live with inefficient light load handling or purchase a crane with two hoists. An example is a crane with a 10-ton main hoist and 2-ton auxiliary hoist for efficiently handling all of the material of various sizes and weights in these installations. The dual torque crane can be provided with a 10-ton capacity heavy hook and a 2-ton capacity light hook operating at 400 per cent of the 10-ton hook capacity speed. Handling all of the various shapes and weights of material is much more efficient with this crane than with either a single hook or a crane having both a main and an auxiliary hoist. In an application of this type, all of the desirable characteristics of the d-c variable voltage system supplied from either a prime d-c source or in these cases an a-c source, are retained at a cost less than a double hoist crane whose efficiency would approach that of the dual torque crane.

For roll shop, mill service, machine shop, powerhouse, and motor room cranes the float control feature of dual torque would be of considerable advantage in placing equipment into roll stands or in placing rolls to be turned in the tools. The accurate very low speed control characteristics of float control would be a great advantage in placing equipment precisely as required and would minimize damage to bearings, roll stands and tools which are caused by sudden dropping of the load into position. For example, in the steam generating field, float control permits placing the high pressure steam turbine cover over the turbine quickly and precisely. It requires a period of approximately 30 min from start to finish. Previous methods required lowering the turbine cover into approximate position by jerky incremental inching of the crane. Final seating in place sometimes required the use of hydraulic jacks. This operation required approximately three to four hours. With float control, the equipment is placed over the dowels on the high pressure steam turbine and lowered at a rate of approximately 4 to 6 in. per min. This speed permits continual checking of the progress of the high pressure cover and precisely controlled lowering under the direct control of the operator and with immediate arresting of the load without bounce or stretch of the ropes. The cover is lowered through its complete cycle onto the bottom housing without the use of additional jacking devices or leveling screws of any kind. Time savings of this type can be duplicated in the steel industry.

In summary, the development of this system was undertaken to provide a rugged dependable safe crane control that is most adaptable to the crane operating problems of the steel industry. This system employs a minimum amount of equipment at a lower cost yet retains all of the advantages of the high cost systems. The results are reduced captial expense and lower maintenance for the user.

Discussion

PRESENTED BY

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A. H. MYLES, Chief Engineer, E C & M Div., Square D Co., Cleveland, Ohio

C. H. ZWEIFEL, Chief Engineer, Pacific Coast Engineering Co., Alameda, Calif.

S. Rifkin: Undoubtedly, Mr. Zweifel will agree that many cranes do not require the refinements of adjustable voltage although there are an increasing number of installations where economic evaluations based on both the short range and long range viewpoints are resulting in the use of adjustable voltage. These evaluations must consider equipment cost, installation expense, performance features, ease of training new operators, mechanical and electrical maintenance, etc.

At the AISE Annual Convention in 1944, J. A. Jackson and M. A. Whiting presented a paper, titled "An Improved System of Electric Drive for Cranes," that described an adjustable voltage system with several novel features. See 1945 Proceedings AISE. A maximum empty hook hoisting speed on the order of 225 per cent rated full load speed was provided. In both hoist and lower directions the maximum available speed increased gradually as the load on the hook was decreased. These desirable features were inherent in the drive, and the operator simply used a single conventional master switch to obtain these features automatically. The heart of the system was the cross-flux exciter, which operated as a regulator to weaken the motor field and increase the generator voltage as a function of the motor armature current which decreased when handling lighter loads.

This system was used on many large construction gantries, power house cranes, the gigantic cranes at Hunter's Point Naval Shipyard and over 700 cargo winches. Two major obstacles probably delayed wide acceptance of this drive for industrial cranes. First was the reluctance to accept motor-generator sets on cranes for several years following the 1944 paper, and second was the relatively high price of the special motor-generator set with the cross-flux exciter. The tremendous increase in the use of adjustable voltage drives for many industrial applications, including ore bridges and unloaders, helped overcome the first obstacle. A modification of this system that eliminated the special exciter and utilized packaged control with the motor-generator set helped overcome the second obstacle. This modification was described as part of the paper, "Crane Drives —When Adjustable Voltage and Why" presented at the AIEE Technical Conference on electric overhead cranes in March, 1955, and printed in "Electrical Engineering," July, 1956.

Since 1951 the modified system has been in use on many cranes, including some with severe repetitive duty cycles. For the past few years the optional addition of a vernier control between the normal first hoist and the first lower speeds has been available to provide the float control described by Mr. Zweifel. Almost 100 adjust-

able speed packages have been supplied for use on cranes, some with shunt-motors and some with compound-wound motors. One installation on a scrap yard crane in a west coast steel mill has been in service over four years during which time the only maintenance work required, in addition to occasional lubrication, was the replacement of brushes.

A group of five cranes supplied to an appliance factory in 1954 has a single hoist with an adjustable speed package and compound motor instead of the two hoists the purchaser had originally requested to handle the wide range of loads. As Mr. Zweifel mentions in his paper, this procedure reduces the total cost of the cranes and provides many other advantages. However, consideration must be given to the fact that on some cranes the main and auxiliary hoists may be required to operate simultaneously, and on high capacity cranes the main hook may be too cumbersome for handling some types of light loads.

Although many dates have been mentioned in this discussion, it is not intended to be a history of adjustable voltage hoist drives. If it were, it should start back at least in 1917 when a gun quenching crane with flexible cables for connection to a stationary motor-generator set was supplied to an eastern steel mill. Motor field weakening and increased armature voltage provided fast operation for quenching as well as for handling light loads.

The basic principles of the features described by Mr. Zweifel have been proved to be practical on many installations. However, the light load speed of 400 per cent requires special design attention to avoid instability problems.

A. H. Myles: The continued effort to improve the performance and safety of crane control is indicative of the importance of this material handling tool. Because our company builds many types of a-c crane control, d-c constant potential control, and adjustable voltage control, the following comparisons will naturally be with those schemes with which we are most familiar.

The continued improvements of a-c hoist control and d-c adjustable voltage control have perhaps equaled or even surpassed in performance the conventional d-c dynamic lowering hoist control but certainly have not surpassed its simplicity, dependability, and inherent safety features. By comparison with the usual adjustable voltage hoist control, the author has described a straightforward and uninvolved scheme although the complete circuitry has not been shown.

Many crane operations naturally require the simultaneous use of main and auxiliary hooks. However, the feature of incorporating light-load high-speed operation into the single main hook has considerable merit. Not being a crane design engineer, I would like to ask the author if it is not necessary to give special attention to gearing, reeving, rope whip, etc., when operation is to be at 400 per cent rated speed.

In commenting on the time saved per trip in bringing the empty hook into position for a lift and in moving the empty hook away after a lift, I would like to point out that 200 per cent speed or faster empty hook hoisting and 150 per cent empty hook lowering speed is standard practice with d-c dynamic lowering control with series-wound motors. The time saving on this bases by the described control would be 12 per cent or less, and not 37½ per cent. Of course, for a-c powered hoists the stated time saving would result.

It should also be kept in mind that the conventional d-c control provides emergency dynamic lowering in case the magnetic brake should, for any reason, fail to hold the load when the master is returned to the off position. Similarly emergency lowering of a load in case of power failure can be accomplished with conventional control by manually releasing the magnetic motor brake. It does not appear that these safety features can be obtained with the control described.

The author mentions the ability to apply the Youngstown power limit stop for maximum safety but does not give circuit details. Since the motor brake is shunt-wound, I assume a current relay is used to set the brake when the limit stop trips. In lowering, the armature current goes through zero on regeneration and would appear to complicate the safe control.

There is one feature in the power circuit of the motor which I would like to question. Since the motor is stabilized shunt-wound, it would appear desirable to connect the motor series field inside the armature-reversing contactor so as to aid the shunt field hoisting and lowering of heavy overhauling loads. This would provide better motor stability when lowering heavy loads, and it would eliminate the need for two collectors for the series field. The bucking effect of the series field when driving down the light hook would be unimportant, and the over-all safety would be improved.

Where direct current is available, as for most steel mill applications, it would be interesting to see a cost comparision between the control, generators, alternator and motor of the described scheme and conventional series motor and control. It would seem that only special and unusual requirements could justify the extra cost. The operation of the selector switch and change of master switches by the operator in handling a single crane motion for different performance seems quite involved and perhaps would be reason for some confusion when handling dangerous loads. I am also concerned about the danger of lifting a heavy load on the heavy load control and then, by mistake, lowering this load on the light load control.

C. H. Zweifel: Insofar as giving special attention to the gearing and rope reeving, we have found that since we employ a d-c motor for the heavy load capacity with a relatively low base speed of approximately 400 to 600 rpm that no particular problems present themselves when operating at the full field weakening range where motor speeds would be 1800 to 2200 rpm. The speeds at full field weakening range are in general not much higher than are experienced on any high speed hoist unit with the exception of the input pinion speed. The gear reducers, of course, are selected so that the peripheral speed is well within safe limits. Drum rotational speed and rope surface speed do not present any particular problems.

With reference to comparative time saving, it is true that standard series-wound constant potential systems provide 200 per cent speed hoisting and 150 per cent speed lowering with the empty hook. The dual torque system described provides 400 per cent speed either hoisting or lowering with an empty hook or with a load up to 20 per cent of rated capacity. The 20 per cent load

speeds in either the hoisting or lowering direction using the d-c series motor are considerably less than the speeds previously mentioned, and thus the time saving when compared with the 400 per cent speed hook is considerably greater than indicated by Mr. Myles, although not as good as would be realized in the example cited in the paper in comparing this unit to an a-c hoist system.

With reference to emergency dynamic lowering protection, the circuit details published in the paper do not indicate the full extent to which we have gone to provide all standard protective features. Any emergency dynamic braking lowering system available with conventional d-c hoist controls can be had with the dual torque crane control. In fact, if it is required to handle a load during a cycle when the hoist motor brake is inoperative, the dual torque system with float control would land an expensive or heavy load much more gently than is possible with the conventional d-c systems. Emergency dynamic braking can be furnished to operate in the event of power failure through a permanent magnet pilot generator mechanically connected to the hoist motor. Its output is impressed on the d-c motor through spring-closed contactors to limit the lowering speed under this power failure condition to a speed which is dictated only by the size of the permanent magnet pilot generator furnished.

It is quite correct that the application of the Youngstown limit stop to this crane control requires the use of a current relay to set the motor brake. Dynamic braking decleration of the hoist components is then accomplished in exactly the same manner as in the conventional d-c systems.

I am quite interested in the comment regarding the location of the motor series field. In fact, it was on this theoretical basis that we first approached the problem. We placed the motor series field inside the armature-reversing contactor and connected it to aid the shunt field hoisting and heavy overhauling lowering loads. However, after considerable experimentation on our 25-ton shop crane, we removed the series field from this location and placed it outside of the loop. This resulted in a much more stable operation. At the moment we have no exact scientific explanation why this is true. However, the fact remains that stability and operation are improved by removing the series field from inside the armature loop. This is the reason for its location in the circuit.

As to the question of relative cost, we must admit that where constant potential direct current is available for a crane with a specific load duty cycle, the cost comparison of this new system will, of course, not be too attractive. However, on applications involving variable load requirements on magnet and bucket cranes, the increased efficiency of the dual torque system will justify the cost. Also, on cranes whose load duty cycle requires a main and an auxiliary hoist, the cost comparison of the dual torque system is most favorable.

We employ no selector switch in the system, merely two master controllers. Either controller when operated blocks out operation of the other. Operator confusion between selection of controllers is not a problem. We also point out that the dangerous situation of lowering a heavy load in the field weakened motor range inadvertently is not possible. If the operator mistakenly selects the light load master controller to lower a heavy load, the motor accelerates to base speed (second point light load) and is prevented from going into the field weakening range. Maximum load may be safely handled on the light load master either hoisting or lowering, but of course, only two speed points of control are available if the load is inadvertently handled on the light load master. The point we specifically want to make is that the crane is completely safe in its operation, irrespective of the load attached to the hook and irrespective of which master controller the operator selects. If loads in excess of the light hook field weakened capacity are placed on the hook, the crane will merely accelerate to base speed in either the hoisting or lowering direction and maintain motion at that speed even though the light load master is being used.

With reference to the various crane control systems described by Mr. Rifkin in his comments, it is interesting to note, in every case, the maximum available speed of the hook increases gradually as the load decreases. In constrast, in the dual torque system, the maximum speed of 400 per cent is consistent over the full range of the light hook capacity, i. e., up to approximately 20 per cent rated load. We also employ five such speed points from zero speed to 400 per cent speed, each speed point maintains, throughout the full range, the preset speed selected by the operator. We believe this feature is most advantageous from the operator's standpoint since he knows exactly what speed he is going to travel at regardless of load, when he selects an operating speed point. Previous d-c or a-c systems have been a step in the right direction in providing higher operating speeds with lighter loads. However, we believe that the system described here with constant speed with any load up to the capacity of the light hook is of greater advantage than the prior systems.

Mr. Rifkin describes several systems. The detailed circuitry and protective devices supplied in these systems are not readily called to mind. Therefore I can make no comment on these applications. It is certainly true that practically all of the individual features proposed in the dual torque crane system have been utilized at one time or another in some d-c variable voltage system. However, we believe that the dual torque crane control system represents the first system in which all of these components and features have been correlated into a cohesive crane control system with complete protection against misoperation, overspeeding and instability. For the sake of operator simplicity, standard crane controllers which eliminate the possibility of operator confusion, are utilized.

In summary, we wish to be the first to point out that the dual torque crane control system is no cure-all nor crane operator's "utopia" which solves all problems. However, as crane designers and fabricators, we believe the system incorporates many features needed in crane operation to increase efficiency and production at a comparable cost to any existing systems and at a very favorable cost comparison to electrical braking systems of the dual hook type. To the inherent problems in crane operation, we brought to bear the talents of motor specialists, crane control specialists, and crane designers. The result was the dual torque crane control system. As previously stated, we believe this system to be the most versatile, smoothest, and safest of all material handling systems in the crane industry. ▲

CURRENT AISE DISTRICT SECTION MEETING NOTICES

BIRMINGHAM SECTION

Monday, March 30, 1959—Social Hour 6:30 P.M., Dinner 7:00 P.M., Meeting 8:00 P.M.

"Development and Operation of Southern Electric Steel Co.," by Hugh P. Bigler, President, Southern Electric Steel Co. Birmingham, Ala.

Thomas Jefferson Hotel, Birmingham, Ala.

BUFFALO SECTION

Tuesday, March 10, 1959—Dinner 6:30 P.M., Meeting 8:00 P.M.

"Rod Mill Furnace Rehabilitation," by D. W. McLean, Superintendent, Rod and Bar Mills, and Karl A. Gmell, Combustion Engineer, The Steel Company of Canada, Ltd., Hamilton, Ontario, Canada

Sheraton Hotel, 715 Delaware Avenue, Buffalo, N. Y.

CANTON SECTION

Monday, March 16, 1959—Dinner 7:00 P.M.

Plant Visitation to Reeves Steel and Manufacturing Co., Dover, Ohio. Visitation will take place after dinner. Transportation will be made in owners' individual cars.

Reeves Hotel, New Philadelphia, Ohio

CHICAGO SECTION

Tuesday, March 3, 1959—Dinner 6:30 P.M., Meeting 7:30 P.M.

"Auxiliary Drive Static Rectifiers," by E. B. Fitzgerald, Apparatus Sales Manager, Cutler-Hammer, Inc., Milwaukee, Wis.

Phil Smidt's Restaurant, 1205 North Calumet Avenue, Hammond, Ind.

CLEVELAND SECTION

Tuesday, March 17, 1959—Inspection Trip 2:00 P.M., (Buses leave 1:15 P.M.)
Dinner 6:30 P.M., Meeting 7:45 P.M.

Inspection Trip: Cleveland Works Div. of the Jones & Laughlin Steel Corp. (Buses will leave Cleveland Engineering and Scientific Center at 1:15 P.M.)

"Controlled Drafting Program for a Reversing Roughing Mill," by T. H. Knox, Superintendent of Blooming Mill and 77-In. Strip Mill, J. W. Culver, Assistant Superintendent of Blooming Mill, J. E. Humphrey, Plant Electrical Engineer, and M. E. Swark, Assistant Tabulating Supervisor, Cleveland Works Div., Jones & Laughlin Steel Corp., Cleveland, Ohio

Dinner and Meeting, Cleveland Engineering & Scientific Center, 3100 Chester Avenue, Cleveland, Ohio

DETROIT SECTION

Tuesday, March 3, 1959—Dinner 6:30 P.M., Meeting 8:00 P.M.

"Application of Special Refractories Material in the Steel Plant," by J. D. McCullough, Chief Engineer, The Babcock & Wilcox Co., New York, N. Y.

Horace Rackham Educational Memorial Building, Dinner and Meeting, Parlors E, F and G, Detroit, Mich.

LOS ANGELES SECTION

Data Not Available.

PHILADELPHIA SECTION

Saturday, March 7, 1959—Dinner 6:00 P.M., Meeting 7:00 P.M.

"Modernization of Steelton's 20-In. Mill," by R. M. Weigle, Superintendent Rolling Mills, Bethlehem Steel Co., Steelton, Pa.

"Automatic Preset Screwdown Controls," by G. D. Nicolson, Assistant Superintendent, Electrical Dept., Bethlehem Steel Co., Steelton, Pa.

Engineers Club, 1317 Spruce Street, Philadelphia, Pa.

PITTSBURGH SECTION

Monday, March 16, 1959—Social Hour 6:00 P.M., Dinner 7:00 P.M., Meeting 8:00 P.M.

"The Battle for Steel Supremacy—The Soviet Union Leads in Raw Materials," by Alexander Gakner, East European Specialist, Division of Foreign Activities, United States Dept. of the Interior, Bureau of Mines, Washington, D. C.

University Club, University Place, Pittsburgh, Pa.

St. LOUIS SECTION

Wednesday, March 25, 1959—Social Hour 6:00 P.M., Dinner 7:00 P.M., Meeting 8:00 P.M.

"Closed Circuit Television in Steel Mill Operations," by M. A. DuBois and Cy Carroll, DuBois Engineering & Manufacturing Corp., Hammond, Ind.

Elks Club, Granite City, Ill.

SAN FRANCISCO SECTION

Tuesday, March 17, 1959—Social Hour 6:00 P.M., Dinner 7:00 P.M., Meeting 8:00 P.M.

Columbia-Geneva Steel Division Night

"Expansion of Electrolytic Tinning Facilities at Pittsburg Works," by T. B. Bruce, Senior Staff Engineer, Sheet & Tin Mill, P. D. Gottschall, Senior Staff Engineer, and R. L. Dowell, Assistant to General Superintendent, Columbia-Geneva Steel Div., United States Steel Corp., Pittsburg, Calif.

Shattuck Hotel, Shattuck & Alston Way, Berkeley, Calif.

UTAH SECTION

Utah District

Monday, March 9, 1959—Social Hour 6:30 P.M., Dinner 7:30 P.M., Meeting 8:30 P.M.

"Purchasing Policy of U. S. Steel," by H. W. Christensen, Director of Purchasing, Columbia-Geneva Steel Div., United States Steel Corp., San Francisco, Calif.

Pueblo District

Tuesday, March 17, 1959—Social Hour 6:30 P.M., Dinner 7:30 P.M., Meeting 8:30 P.M.

"Manufacture & Utilization of Pre-Stressed Strand," by R. W. Anderson, Research Engineer, The Colorado Fuel and Iron Corp., Pueblo, Colo.

Minnequa University Club, Pueblo, Colo.

YOUNGSTOWN SECTION

Monday, March 23, 1959—Social Hour 6:30 P.M., Dinner 7:00 P.M., Meeting 8:00 P.M.

"New Tools for Steel Quality Improvement," by W. A. Black, Assistant Director of Research, Electro-Mechanical Research Center, Republic Steel Corp., Cleveland, Ohio

Mahoning Country Club, Girard, Ohio

Continuous Annealing 60 Tons Per Hour of Tin Plate

by Quentin M. Bloom, Manager,* Furnace and Kiln Div.,
Selas Corp. of America, Dresher, Pa.

For a given tonnage, choice of a multi-line moderate speed facility rather than a single higher speed line offers easier operating, lighter material handling equipment, simpler material flow patterns, more scheduling flexibility . . . a less expensive standard mill building for housing is required . . . . line equipment is of simple design and more easily maintained . . . . higher line operating efficiency is obtained as a result of fewer passes and fewer rolls . . . . production rating can be increased by making only minor alterations.

WITHIN the past year, Bethlehem Steel Co. has increased the potential tin mill products annealing capacity of the Sparrows Point, Md., mill by 400,000 tons per year by installing four continuous annealing lines. Installation was started early in 1956 and completed in March, 1957. Crews have been trained since May, 1956, and the lines have begun operating on a production basis. Since the writing of this paper engineering developments have permitted the adaptation of the compact furnace design described here to strip annealing web speeds as high as 2000 fpm.

The importance of this continuous annealing installation, rated at 60 tons per hr, can be gaged by the recent growth in tin mill products, revealed in Figure 1. Within a 10-yr period the production of electrolytically coated tin plate has increased from 1,618,000 tons in 1947 to 4,670,000 tons in 1957. This represents an increase of almost 300 per cent. During this same period continuous annealing has progressed from a dream to a curiosity to a reality—so real that by 1957 it represented 20 per cent of the tin mill products of the nation's producing steel companies.

Tin plate production is still on the increase, and a conservative estimate is that it will exceed 6,000,000 tons per year in 1959. By that time an estimated 2,200,000 tons or 36 per cent will be continuously annealed.

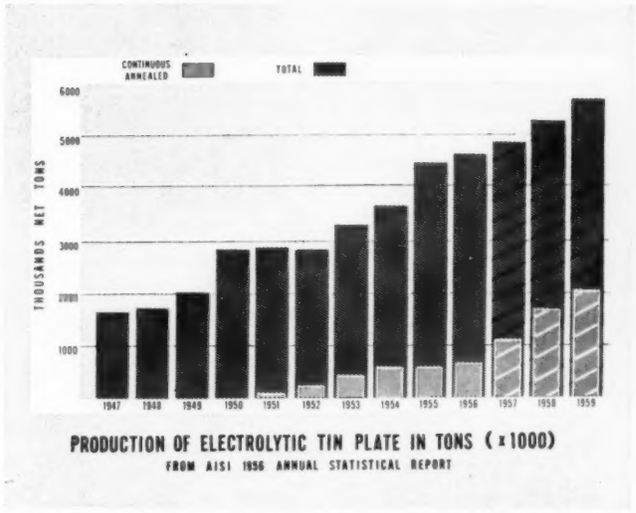


Figure 1 — Within a 10-yr period the production of electrolytically coated tin plate has increased almost 300 per cent.

With this market trend in view, Bethlehem decided in 1955 to install continuous annealing capacity of 60 tons per hr. At that time three principal means to this end were suggested. The required capacity could be obtained by installing one 2000-fpm line. The bottom diagram of Figure 2 shows the heating, holding and cooling sections of such a line, then proposed, and now installed at another steel plant. The middle diagram in Figure 2 demonstrates a second approach, two 1000-fpm lines, the heating, holding and cooling sections of which are illustrated. The third method lay with four 500-fpm lines, analyzed in the top diagram. Figure 2 illustrates the number of passes and the number of rolls in these types of continuous annealing lines.

The decision to build four 500-fpm lines was based on Bethlehem's more than ten years research in continuous annealing and its operating experience on other continuous strip processing equipment. Observation of

* Position at time of paper presentation.

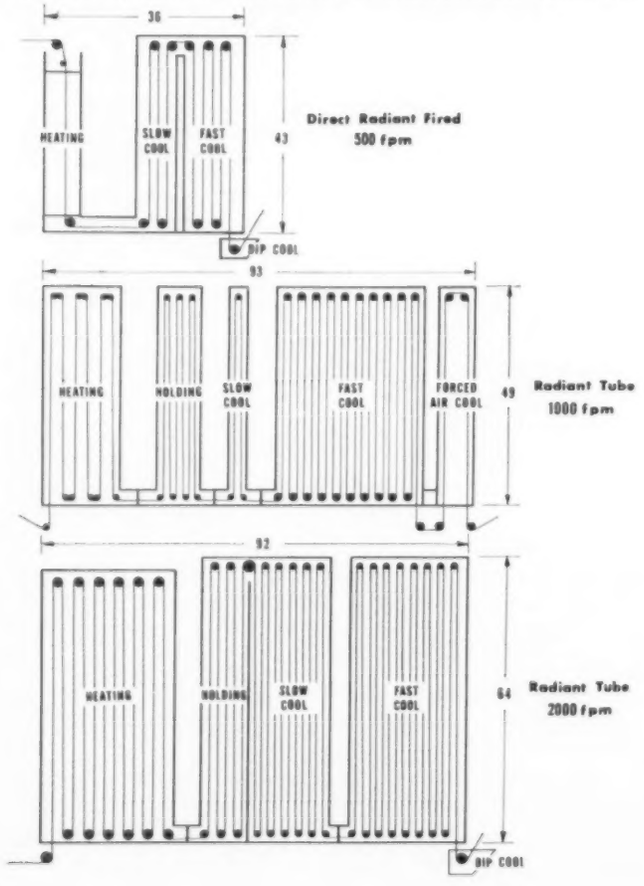
continuous annealing elsewhere in the steel industry also contributed to the final choice.

The research, resulting from earlier Bethlehem investigations, was a co-operative program undertaken shortly after World War II by Bethlehem and the author's company to bright-anneal low carbon steel strip continuously. The objectives of the test were to produce strip that would respond properly to standard steel mill pickling and tinning practice and meet tin-plate corrosion test standards. It must also have satisfactory forming characteristics for can manufacture.

Small coupons were used initially to make this evaluation. The test proceeded satisfactorily so that in 1947 we were able to set up the continuous annealing pilot line shown in Figure 3 in our laboratory. This line operated at speeds up to 150 fpm and handled 5¼-in. wide strip and coils up to 1500 lb. The illustration shows the winding reel and the discharge end of the continuous annealing pilot line. Through these tests it was learned that steel could be rapidly heated in a direct-fired furnace and remain bright and clean. It was also discovered that annealing temperature was not critical, that there were specific optimum cooling rates which should not be exceeded to obtain desired annealing characteristics, and that these characteristics were obtainable without any soak.

Material produced on the pilot line was tested and found to have a number of desirable characteristics. A continuously annealed product had been produced to meet the specifications required for can manufacture. Factors that must be considered in a full scale continuous annealing process had been evaluated.

Figure 2 — To increase their production potential Bethlehem had three alternatives, one 2000-fpm, two 1000-fpm or four 500-fpm lines. They chose to install four 500-fpm lines.



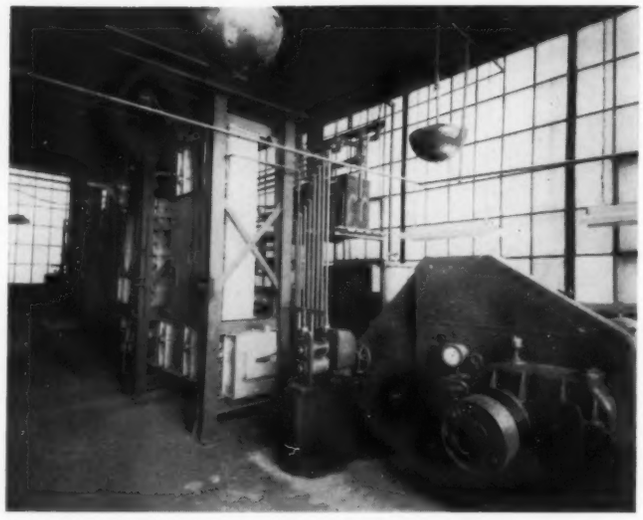


Figure 3 — In 1947 the supplier set up a 150-fpm continuous annealing pilot line to determine the relative effects of the process variables. The discharge end of the line is in the foreground.

Bethlehem drew further information from their experience in operating 1000 to 1200-fpm electroplating lines. The skein type plating lines have a maximum efficiency at 900 fpm. Above this speed the fineness of the strip movement electric control is lost, mechanical alinement is difficult, and roll maintenance is excessive. Building of a 900-fpm continuous bright-annealing line seemed to be the logical answer, but higher strip speeds meant cumbersome and costly equipment. Bethlehem decided the basic need, however, was a line that would do the job simply, efficiently and economically without a great expenditure of time and space. Preliminary calculations, based on the pilot line and on other continuous annealing lines, indicated that the 500-fpm line shown in Figure 2 could do the job.

Furthermore, the studies summarized in Table I convinced them that the 500-fpm strip speed provided the most economical operation in terms of strip length in process. The lines, as installed, are rated at 15 tons per hr each depending on gage, width and other operating factors, but individual lines have satisfactorily annealed over 19 tons per hr on limited runs. In fact, the design is such that possible future speeds of over 700 fpm (22 tons per hr) will require only relatively minor alterations.

A number of significant economies seemed to result from the 500-fpm strip speed. A line designed for moderate speeds and production capacities should operate with relatively few interruptions and produce a high prime yield. Further, a moderate speed line would minimize, if not eliminate, the need for careful selection of the cold reduced coils fed into the line. If this is not done, operating difficulties occur in higher speed installations. It also avoids a number of problems that arise as speeds are increased. These problems are lubrication of hot rolls, tension control, storage of strip in the looping towers, and, in fact, the tracking of the strip through the line.

In the case of the 15-ton per hr annealing line it was found that the short time-temperature annealing

TABLE I
Comparison of 500-fpm and 700-fpm Annealing Lines

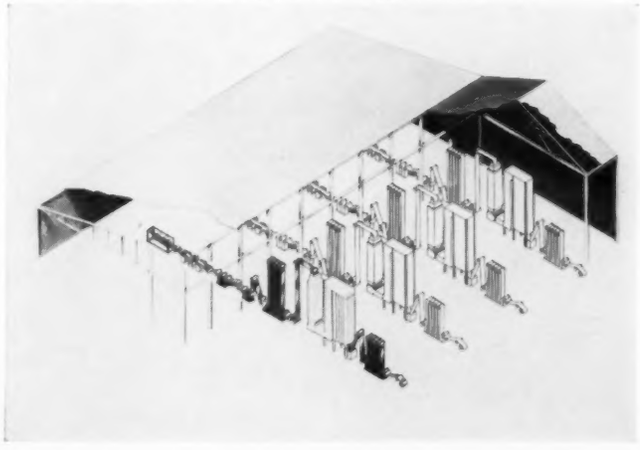
Furnace section	Entering temperature, F	Exit temperature, F	Time in section, sec	Required strip capacity of sections, ft		Installation length, ft
				500-fpm strip speed	700-fpm strip speed	
Heating	Room temperature	1250	3	25	35	30
Slow coil	1250	900	10	81	113	146
Fast coil	900	600	15	125	175	223
Dip tank	600	..	..	8	8	8
Total	...	..	..	239	331	407

cycles determined in our research work could be built into a moderate speed unit installed in a building as shown in Figure 4. The annealing furnace, including cooling sections and looping towers, could be installed in a 100-ft wide normal mill building. The handling equipment at each end of the line could be installed in relatively inexpensive lean-to type buildings so that the flow of material was across the width of the building. Expansion possibilities can also be realized. Another line can easily be installed by extending the building one 25-ft bay and making a parallel installation, all without altering the material flow in or out of the continuous annealing area.

This arrangement adapts itself ideally to logical material handling arrangements. The work flows into the building at the left, through each of the four annealing lines, and leaves the building at the right, as illustrated in Figure 5. Note that the handling equipment consists of two pay-off reels, designed to handle 73-in. maximum outside diameter coils, followed by a two-pass pinch roll, a two-pass crop squaring shear, a double seam welder, and a pinch roll at the entry end. The strip then runs through an electrolytic cleaning section, a bridle roll and a feed looping tower. This is followed by another pinch roll and a tension regulating unit that immediately precedes the annealing furnace and cooling unit. This equipment can be seen in Figure 6, which shows the charge end of annealing lines 1 and 2. Immediately following the annealing unit is the No. 2 pinch roll, the exit looping tower, the No. 3 pinch roll and a single tension winding reel. This equipment is shown in Figure 7.

The annealing lines were designed for a rated capacity of 15 tons per hr each. Each has a nominal line speed of 500 fpm with a maximum speed of 715 fpm and is designed to handle strip up to 44 in. wide in thicknesses from 0.0066 to 0.015 in. Each line is designed to operate at a preset constant speed and without slowdown for welds or coil splicing.

Figure 4 — It was determined that the cooling and looping sections of four lines with the required short time-temperature annealing cycle, could be installed in a standard mill building 100 ft wide with their coil handling equipment in less expensive lean-to type building extensions.



The annealing unit itself, which consists of a single-pass heating furnace and retarded cooling and fast cooling sections, is neatly and compactly arranged. The annealing unit looking at the discharge end of the unit and the graphic control panel arranged just under and to one side of it are shown in Figure 8.

The annealing unit is more clearly illustrated in Figure 9, a diagram showing the single-pass heating furnace and its relation to a three-pass retarded cooling section and a five-pass fast cooling section which is followed by a water dip tank.

The strip enters at the top left hand side of the diagram and passes downward through the vertical furnace. This furnace is direct-fired by use of radiant type gas burners, which are automatically removed from the strip, in a matter of seconds, when strip stoppage occurs. The burners can be removed by the operator when threading.

The strip passes downward through three controlled heat zones, each of which consists of a pair of panels, one on each side of the strip. Each panel is studded with a number of gas-fired radiant burners, which face the flat of the strip at a distance of 7½ in. They are so arranged that the strip temperature without soaking, is completely uniform as it leaves the high-temperature furnace.

The radiant burner has a ceramic cup which becomes incandescent as the flame wipes its surface. Catalyzing of the combustion results. Much of the heat liberated is converted into radiant energy which is characterized by fast, uniform heat transfer that is adaptable to fast, accurate control.

After passing through the heating furnace, the strip goes through a pair of seal rolls and then enters the cooling section. Throughout the cooling unit, from the seal rolls directly under the furnace to the boot leading into the water dip tank, the strip is protected from oxidation by a protective atmosphere.

The slow or retarded cooling section consists of a bottom crossover duct and a three pass vertical refractory-lined cooling chamber. The bottom crossover duct is equipped with electric heating elements controlled by a proportioning control system. This system is used in conjunction with strip temperature measurement. The three-pass vertical cooling section is also equipped with electric heating elements and complemented with air-cooling tubes. This chamber, through

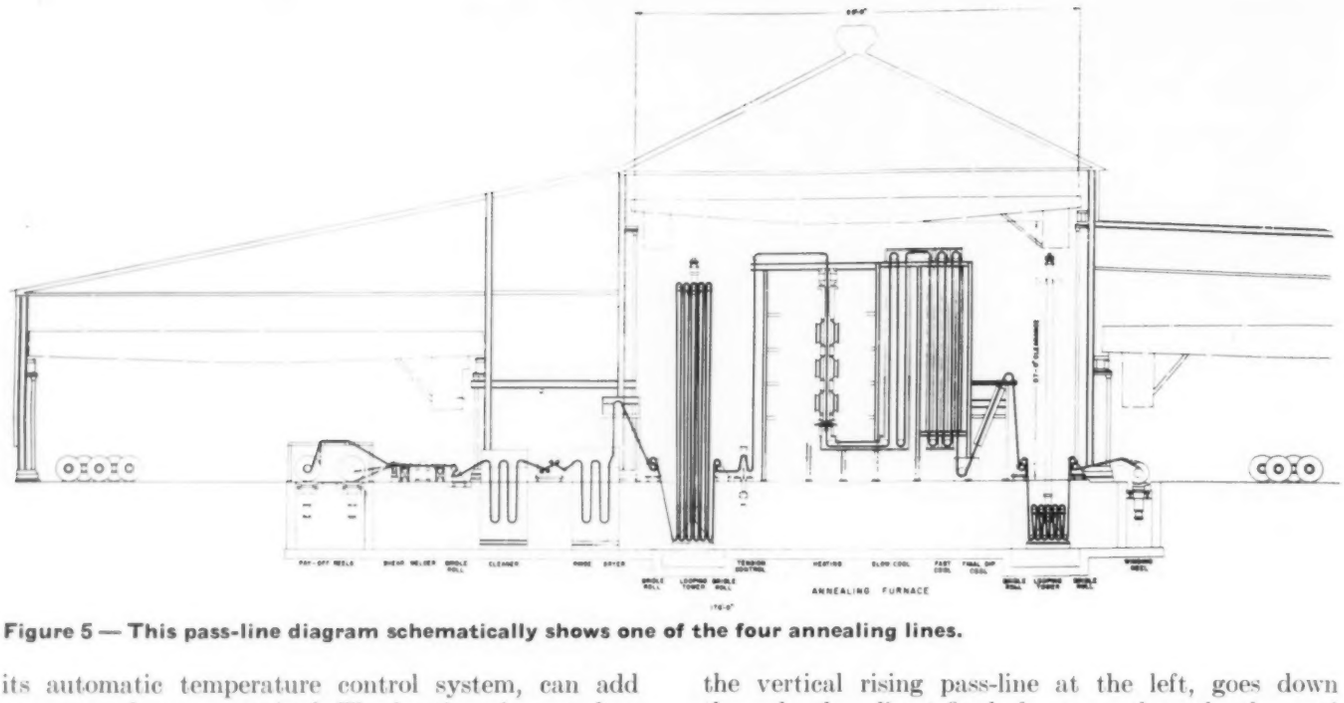


Figure 5 — This pass-line diagram schematically shows one of the four annealing lines.

its automatic temperature control system, can add or remove heat as required. The heating element does not function when the line is operating. Its purpose is to maintain a temperature condition in the retarded cooling unit when strip stoppage occurs or to prepare the unit for operation after a weekend or other shutdown.

The five-pass rapid cooling section immediately follows the retarded cooling section and consists of five completely enclosed water wall ducts through which the strip passes. Each of these five vertical cooling ducts is divided into three units so arranged that the water flowing into the wall of the duct is individually regulated and manually controlled.

Immediately following the water-jacketed fast cooling section the strip enters a dip tank where it is cooled down to approximately 125 F. It then passes through a pair of squeeze rolls and a strip dryer before entering the exit looping tower.

Threading is greatly simplified. Table II lists the times required to repair breaks in the various parts of the line and the total downtime for each. It is possible that these times may be further reduced as the crews become more experienced.

Figure 9 shows the strip pass-line which starts at the vertical rising pass-line at the left, goes down through the direct-fired furnace, through the seal rolls, and into the slow cool and fast cool chambers of the line. Four of the upper rolls in this section are driven for easier threading. Overriding clutches are provided, however, because no driven rolls are required in the heating and cooling sections during normal operation. At the right are shown the water dip tank, the squeeze or wringer rolls, and the strip dryer. The strip leaves the annealing unit and goes to the exit looping tower.

The entire process is controlled from a central

Figure 6 — Coils are being charged into annealing lines 1 and 2.

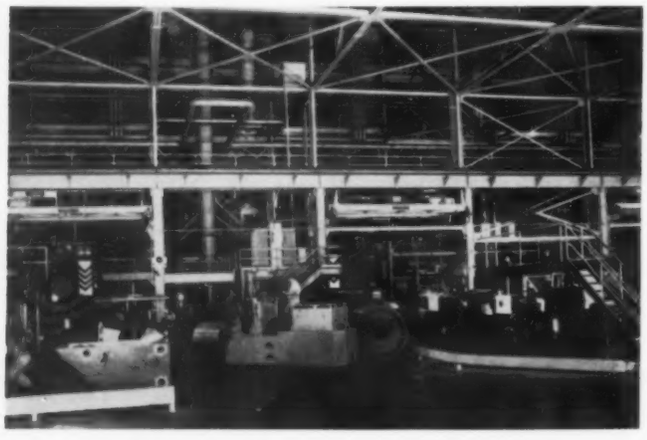


Figure 7 — The delivery ends of the annealing line have two pinch rolls, an exit looping tower and a winding reel.

TABLE II
Strip Repair Time, Continuous Annealing Furnace

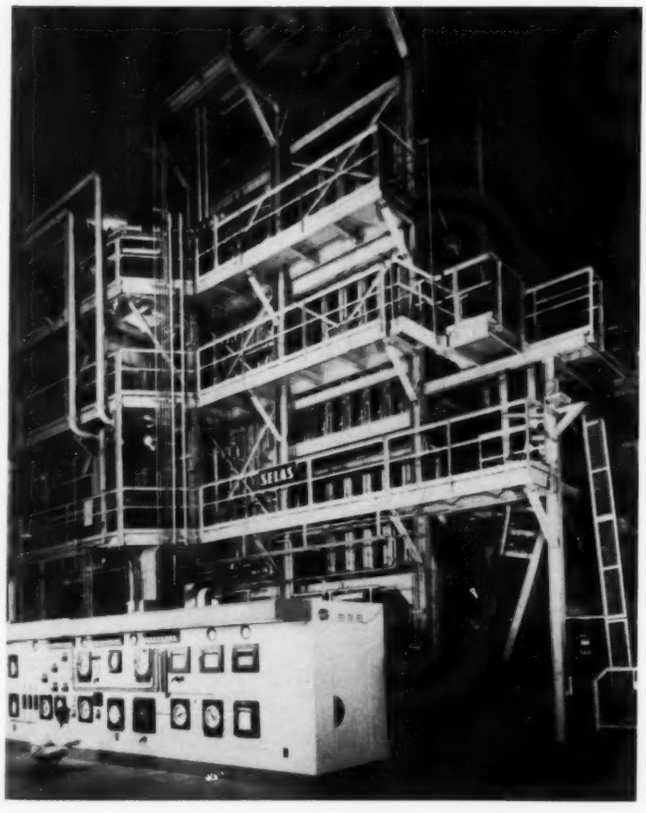
Location of Tear	Repair Time	Total Downtime
Looping tower	45 min	1 hr 45 min
Washer	1 hr 30 min	2 hr 30 min
Furnace	1 hr 00 min	2 hr 00 min
Crossover	2 hr 00 min to 2 hr 30 min	3 hr 00 min to 3 hr 30 min
Slow cooling	2 hr 00 min to 2 hr 30 min	3 hr 00 min to 3 hr 30 min
Fast cooling	45 min	1 hr 45 min
Dip tank	45 min	1 hr 45 min

control cubicle arranged as a graphic panel and shown in Figure 10. The panel illustrates graphically the heating furnace and the three zones of fuel input and control in the furnace, the slow cooling chamber, the fast cooling chamber, and the water dip tank. Various instruments automatically regulate the rate of fuel flow into the furnace, record, and control the temperature of the crossover duct; record and control the temperature of the slow cool unit; and control the water temperature of the dip tank. Other functions such as strip speed, furnace pressure, fuel input, atmosphere gas pressure, dew point of atmosphere gas, hydrogen content of atmosphere gas and cooling water temperature at various locations of the unit are all controlled and/or recorded from this central graphic cubicle.

All of the heating is accomplished in the single-pass vertical furnace. The exposed time is about 3.6 sec when strip is run at 500 fpm. The furnace is approximately 30 ft long.

A typical curve is shown in Figure 11. It indicates the strip temperature passing through the vertical annealing furnace, i.e., its temperature at various stages of progression. To determine what happens to the strip, how rapidly it heats up, and what kind of curve is obtained; a series of tests were undertaken.

Figure 8 — The annealing unit consists of a single-pass heating furnace, a retarded cooling section and a fast cooling section.



The entire annealing cycle of this line is considerably shorter than many of the other types of continuous annealing lines now in operation. It requires only 49 sec as compared with two min required by some operating annealing line installations.

To monitor this cycle strip temperatures are measured at various points along the unit, shown in Figure 9 as follows:

1. Directly below the furnace.
2. At the end of the bottom crossover duct.
3. At the top of the first pass of the slow cool section.
4. At the bottom of the third-pass of the slow cool section.
5. At the top crossover pass between slow cool and fast cool sections.
6. At the top between the second and third pass of the fast cool section.
7. At the bottom of the fifth pass in the fast cool section.

A typical curve based on these measurements is shown in Figure 12. Temperature is related to time as a point on the strip passes through the furnace, moves across to the slow cooling section without holding of any kind, and progresses on through the fast cooling section to the final water dip tank cooling unit.

From a metallurgical standpoint continuous annealing of tin plate is somewhat an inflexible process. This is not a limiting factor, however, because the product can be successfully applied to a major portion of tinplate applications, a few of which are shown in Figure 13. The fine grained annealed product, identified as possessing a universal temper commonly called TU, is stiffer and stronger than batch annealed tin plate, but is characterized by improved uniformity, corrosion resistance and drawability.

The aim of short cycle treating is to effect softening by recrystallizing the distorted cold work ferrite grain structure. This is accomplished by heating to a temperature above the recrystallization temperature (about 1050 F in this case) but below the lower critical transformation temperature (about 1330 F). The extremely short time and relatively low temperature is effective because heating is so rapid that the strip is at a high temperature before nucleation begins. The high heat accelerates the rate of formation of nuclei and provides sufficient energy of activation to effect instantaneous nucleation at all points of stress concentration. Therefore, recrystallization is completed before any growth of the unstrained grains can start.

Within the practical limits of high-speed continuous annealing lines, the holding temperature to produce grain coarsening and carbide agglomeration produces negligible softening effect. Such effects are better controlled by other methods.

The necessity for holding at temperature, therefore, is only contingent upon developing a uniform strip temperature to insure complete recrystallization. In each of these four lines the heating to annealing temperature from room temperature takes place in

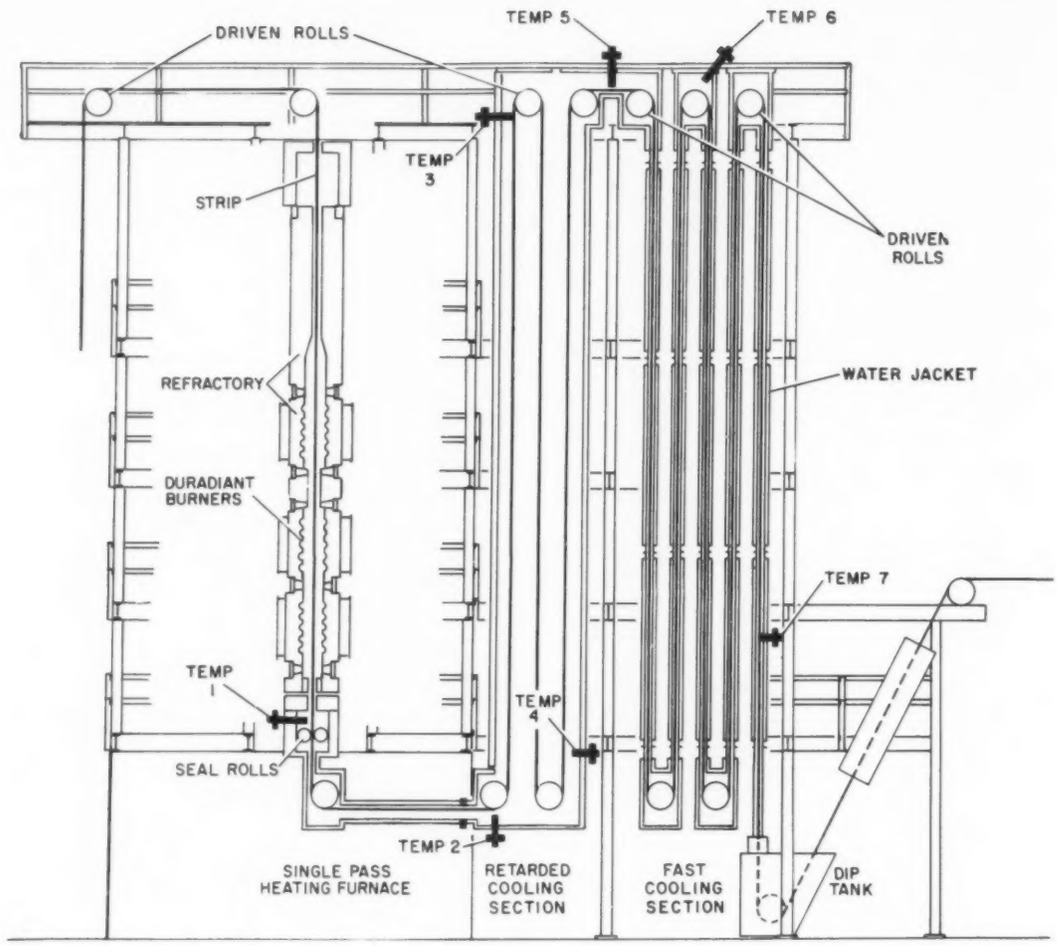


Figure 9 — This pass-line diagram shows the details of the annealing units of the lines.

about 3.6 sec in a single pass without roll contact. Because the full width of strip is exposed on both sides to the uniformly heated panels at high temperature and because each foot of strip goes through the same time-temperature cycle, a uniform annealing temperature results.

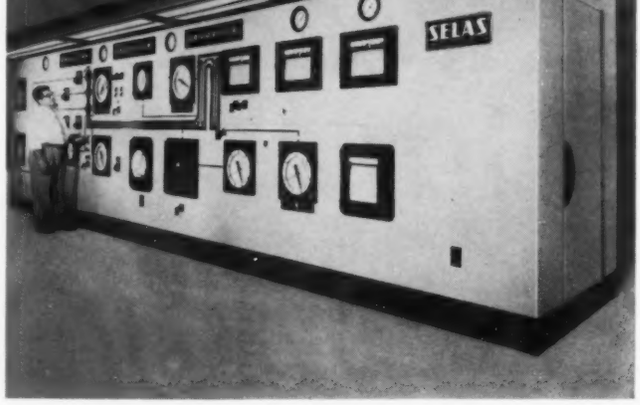
For the balance of the cycle, the cooling is retarded between 1100 and 900 F to permit precipitation of the carbon dissolved during heating thereby avoiding subsequent aging effects. Cooling below 900 F is carried out in water-jacketed ducts after which the strip is water-dipped.

Excellent product uniformity has been obtained on these lines. This is shown in Figure 14 which illustrates the annealed, coated, plated, sheared average hardness using Rockwell 30 T scale for both TU and T6 material. The average hardness for the center and edge varies but half a point for the TU material in the as-annealed condition; the average hardness of the T6 material is the same for its center and edge. The solid lines of Figure 14 represent hardness readings of the edge material and the dotted lines represent the hardness readings taken in the center. In the as-annealed condition as well as coated, plated and sheared, the edge and center curves are very closely parallel, and coincident in places.

Research work reveals that for a given chemical analysis the hardness can be varied only a few points by varying the annealing temperature in the range 1200 to 1600 F. We have also found that a variation of three points in carbon content can change the hardness approximately 4.5 points. In view of the variables that may be present in both the carbon content and hot mill practice, these curves illustrate an excellent degree of uniformity for the continuously annealed product.

The four continuous annealing lines were installed at Sparrows Point during a 14-month period with the first line starting up in May, 1956, and the fourth line starting in March, 1957. During this time numerous crews were trained to operate the lines. Nevertheless the lines performed well achieving quite admirable production rates. Figure 15 illustrates production of various materials that were continuously annealed in

Figure 10 — The entire process is controlled from this panel.



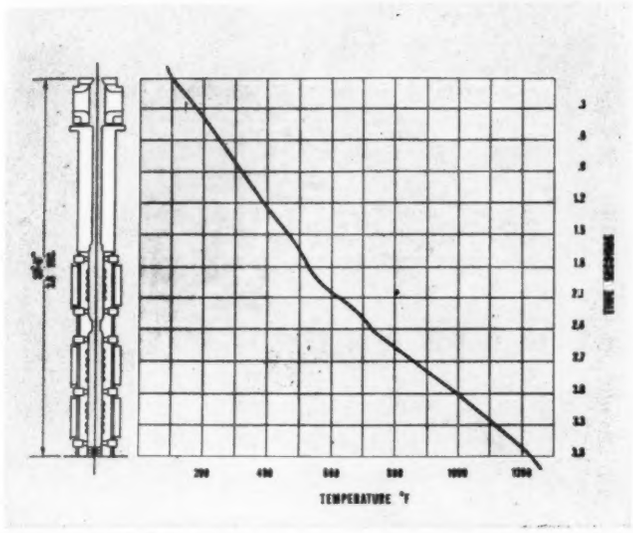


Figure 11 — This graph shows strip temperature in the vertical annealing furnace.

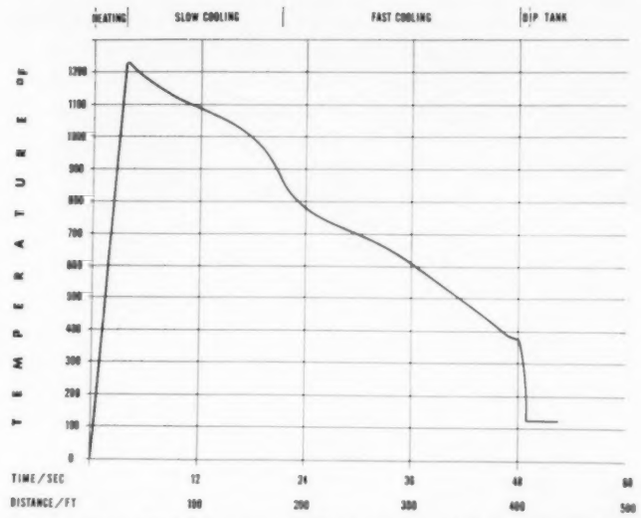


Figure 12 — This time and distance vs strip temperature curve covers the entire annealing process.

line No. 1 in early July of 1957. It is evident that for practically all gages the rated tonnage of 15 tons per hr has been exceeded. It is interesting to know that three days after line No. 4 was started, it was operated at an hourly rate approximately 20 per cent above its rated capacity.

Note that these coils vary from 0.0082 to 0.0124-in. gage. Actually the trend today is to lighter gages, lighter base box of the finished product. This line, though designed for gages up to 0.015 in., has operated over 70 per cent of the time on gages of 0.0094 in. or lighter. It has also operated on gages up to the 0.015 in. Its maximum production to date has been 19.9 tons per hr of 0.0125-in. strip, 33¼ in. wide.

Fuel records are available only for the four lines as a unit. They include startup and crew training but still show consumption of 960,000 to 1,200,000 Btu per ton on a monthly basis. On the same basis, atmosphere gas consumption is 390 cu ft per ton.

As an indication of the excellent uniformity of strip temperature obtained with these lines, examine Figure

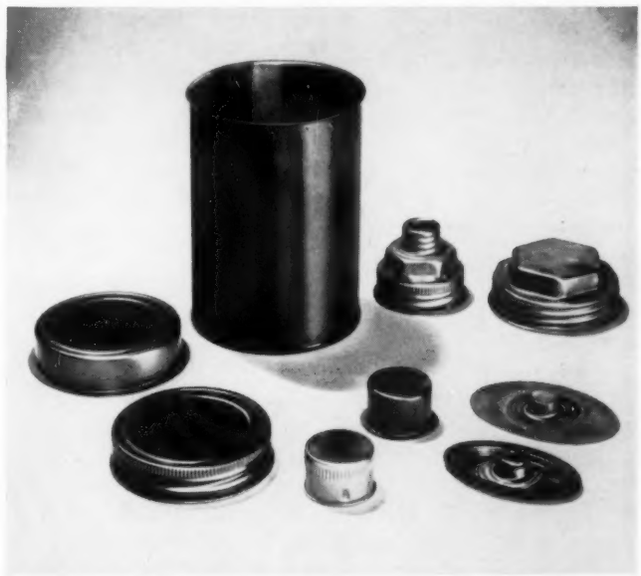
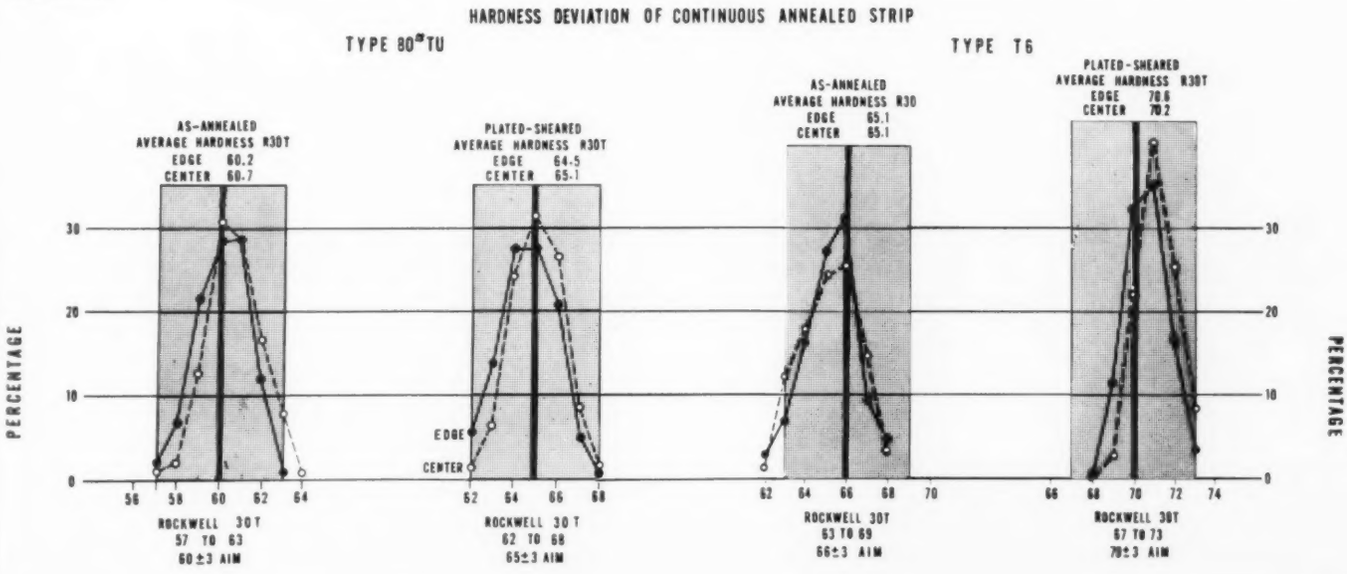


Figure 13 — Annealed tin plate is used for many consumer products.

Figure 14 — These distribution curves indicate that good hardness uniformity is obtained from these continuous annealing lines.



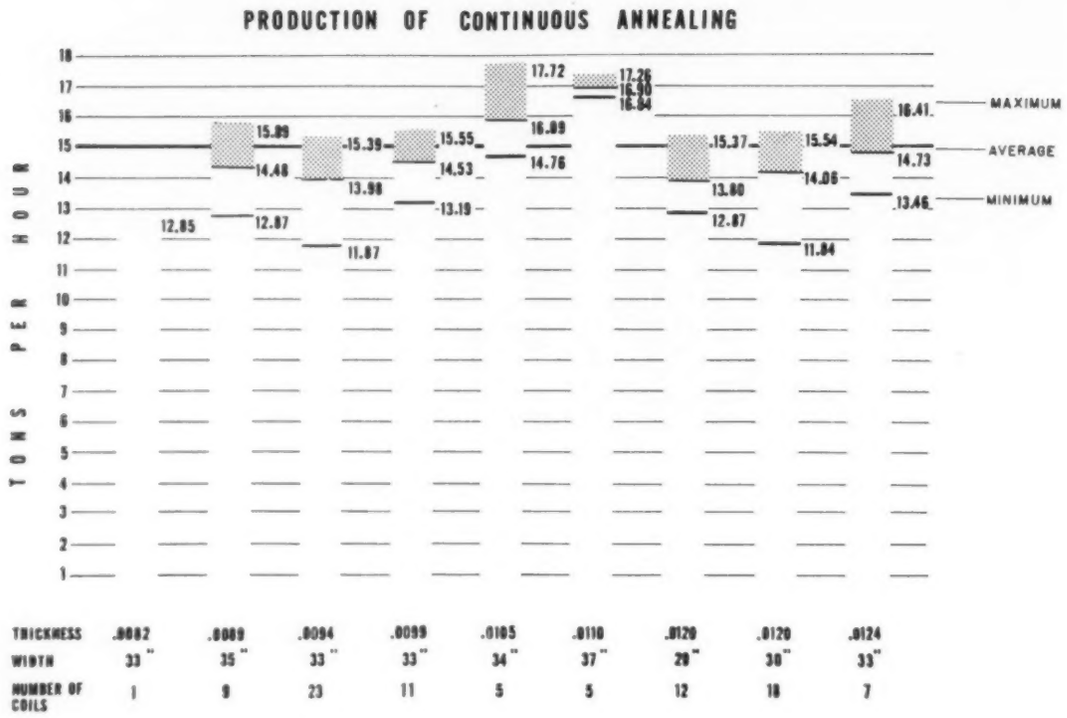

PRODUCTION OF CONTINUOUS ANNEALING
TONS PER HOUR
MAXIMUM
AVERAGE
MINIMUM
THICKNESS .0082 .0089 .0094 .0099 .0105 .0110 .0120 .0120 .0124
WIDTH 33" 35" 33" 33" 34" 37" 29" 30" 33"
NUMBER OF COILS 1 9 23 11 5 5 12 18 7

Figure 15 — This production chart for the No. 1 annealing line in July, 1957 indicates that the rated capacity of the line, 15 tons per hr, was exceeded for practically all gages.

16. This chart records strip temperature at the discharge end of one of the single-pass direct-fired furnaces. This unit was heating strip to 1200 F with a variation in temperature averaging less than 5 F. This chart has a range of 1100 to 1300 F, and each division represents 5 F.

This curve is evidence of how fast the direct-fired furnace settles out and of how closely it holds temperature. Shortly after 4 P.M. it was decided to raise the temperature for the next coil. Note an immediate indication of this temperature change. At 5 P.M. it was decided to further raise the temperature for the following coil. Here again, immediate response to control is evident. Because the furnace is compact, the strip is heated in one pass. Because it is heated largely by radiation from the high-temperature incandescent burner cup cavities, instantaneous response to new temperature conditions or requirements is had without the flywheel effect that is usually present in a large furnace chamber.

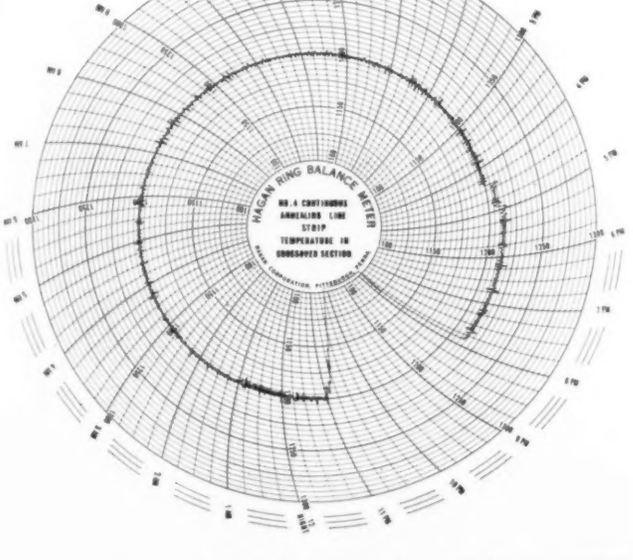
These factors, together with the simplified threading previously cited, shorten startup time to 2 to 2½ hr. A crew starting at 8:00 A.M. will fill the cleaning tanks and dip tank, light the furnace, bring all zones to operating temperature, and start the line by 10:00 A.M. The line will be in full operation, producing acceptable tin plate, by 10:30 or 11:00 A.M.

More than 2½ years of operation by Bethlehem has proved that the 15-ton per hr line represents the optimum for their continuous annealing conditions despite a strong trend in other quarters toward extremes of equipment size and strip speed.

In achieving its desired output of 60 tons per hr, Bethlehem has enjoyed the following advantages from this multi-line installation:

1. Continuous, hour-after-hour production of prime strip.
2. Great flexibility of scheduling to meet simultaneously the needs of several customers.
3. Use of standard mill building and minimum plant space.
4. Simplified material flow patterns with lighter material handling equipment.
5. Economical, easily maintained equipment of simple design.
6. Provision for the current market trend toward greater strip widths and lighter gages.
7. Operating ease especially in change-over, startup and strip rethreading.
8. Minimum number of passes with few rolls for high mechanical and electrical efficiency.
9. Conservative production rating (already exceeded) that can be significantly increased if

Figure 16 — This 24-hr chart of the strip temperature at the discharge end of one of the single-pass direct-fired furnaces shows the excellent uniformity of strip temperature.



desired by simple, inexpensive alterations to the furnace.

Increasing competitive pressures from the aluminum and plastic industries could conceivably force the tin plate manufacturer to lighter gage material in greater widths. The lighter gage material offers additional handling hazards in a strip annealing line. This compact annealing unit, which incorporates a single-pass heating furnace, seems ideally suited to meet this trend.

For mills requiring higher strip speeds this compact furnace design has been adapted to production rates up to 60 tons per hr per furnace and web speeds up to 2000 fpm.

Discussion

PRESENTED BY

J. A. WARD, Superintendent, Cold Reduction, Tinning and Galvanizing, The Steel Company of Canada, Ltd., Hamilton, Canada

NORMAN B. JONES, Specialist, Process and Application, Furnaces & Associated Equipment Sales, General Electric Co., Shelbyville, Ind.

QUENTIN M. BLOOM, Manager, Furnace and Kiln Div., Selas Corp. of America, Dresher, Pa.

CHARLES A. TURNER, Chief Metallurgist, Selas Corp. of America, Dresher, Pa.

W. H. SWISSHELM, Assistant Superintendent, Tin Plate Dept., Inland Steel Co., Indiana Harbor Works, East Chicago, Ind.

R. E. NOBLE, Engineer, Rolling Mill Dept., Mesta Machine Co., Pittsburgh, Pa.

FRANK LANNING, Manager, Steel Mill Equipment Div., Drever Co., Bethayres, Pa.

W. M. BLOOM, Fuel Engineer, Allegheny Ludlum Steel Corp., Brackenridge, Pa.

J. A. Ward: Our continuous annealing line at The Steel Co. of Canada has an electrically-heated furnace section consisting of four 50-ft passes of heating and two 50-ft passes of holding section. These are followed by the necessary sections, slow, fast, cool and quench tank. Our line is electrically and mechanically designed for 1000 fpm but up to the present time we have only furnace and cooling capacity for 18½ tons per hr approximately 600 fpm for an average strip gage.

In view of the rather substantial differences in our line and the one discussed by Mr. Bloom my comments will necessarily be related to the experience we have had with our unit. I must agree that under average operating conditions we have reason to believe that speeds over 600 fpm appear to have questionable gain in tons per hr over a long period. In spite of the above furnace limitations, we have operated on some light gages for lengthy periods at over 800 fpm. The ability to control and detect faults in the material being charged to the unit is, of course, an important factor in considering the top speed of the continuous anneal line. Such faults can cause trouble and lengthy delays at any point in the unit. From our experience higher speeds have increased our tracking problems at the quench tank. It appears that we get a water cushion which starts the strip skidding sideways under some conditions in spite of our taking counter measures such as grooving, crowning of the sink rolls, etc.

Mr. Bloom's point of selected material being charged to the line is well taken although this is not too great a problem on our installation at moderate speeds. It can mean that the old horizontal cleaner can end up being a salvage unit for material not suitable for charging into the continuous annealing line.

We were in the rather fortunate position of installing a line for a required production of approximately 18 tons per hr. The basic requirements of such a line embody somewhat the same principles and equipment as a line for 30 tons per hr. Considering that factor we felt it would not be too costly an experience to design the line for 1000 fpm and work up to the 30 tons per hr. From operating practice we eventually found this to be reasonable. We operate our unit with a three man crew. Certainly we would have to give considerable thought to duplicating our force if we were capable of producing double the tons per hr with the same crew requirements. This is yet to be determined. Therefore I do not feel qualified to argue against the point of a duplicate number of lower producing units. With rising labor costs this is an important factor. Possibly our approach to the problem will provide an answer in the near future.

I would certainly agree with the findings of uniformity of product produced, but there would be some question in my mind of any recognized improvement in corrosion resistance in strand annealed material over coil annealed material.

It has been our experience, generally, that tracking problems in the furnace are not of great concern and do not appear to increase too much with increase in speed. I would be more inclined to say that any material that will track sufficiently well to get to the furnace section, and continue to track after the anneal section, will not give too much concern in the annealing unit itself.

Norman B. Jones: We have more than a passing interest in the success of this installation as the protective atmosphere for these annealing furnaces and Bethlehem's continuous galvanizing furnaces are supplied from six of our hydrogen-nitrogen generators.

Mr. Bloom has indicated that no soaking time is required. Not being a metallurgist, I am certainly not going to challenge this statement. However, it is not in agreement with the findings of A. F. Mohri of Stelco, author of a paper before the American Iron and Steel Institute in 1956. Mr. Mohri found a relationship between the total time above the recrystallization temperature of approximately, say, 1100 F and the final hardness. His findings indicated a minimum of 25 sec for optimum results. He designates this time as effective soaking time. Using this definition, I would like to ask Mr. Bloom if he would agree that his curve, which is Figure 12 in the text, indicates an effective soaking time of approximately 10 sec.

The paper points out that only 49 sec are required for the entire annealing cycle, and other furnaces require up to two min. This could have reference to the annealing furnace in the center of Figure 2. This is like our 30-ton per hr furnaces at U. S. Steel Gary, and Fairless works. They have a total time of 104 sec. Considering only the differential in time, approxi-

mately 15 sec is chargeable to the heating with the rest to holding time and added cooling time.

These furnaces have what we might call a "dry cool" with the strip emerging to room air at approximately 300 F rather than being quenched at 600 F or below. What I am trying to point out here is that radiant tube heating furnaces, if built otherwise the same as these direct-fired furnaces, would have a total time of 64 sec. as compared to 49 sec.

I believe Mr. Bloom's point about multiple units is a good one which has to be considered by the user. The important question here is what constitutes the economic size, and this, in the final analysis, has to be decided by each prospective purchaser after weighing all the facts.

Some people feel that a new annealing line should be designed electrically and mechanically for at least 1000 fpm even though at present they only install annealing capacity for 500 or 600 fpm. At Youngstown, for example, they are accomplishing this by having the annealing furnace built for 500 fpm now but convertible to 1000 fpm later. The ultimate cost will be approximately the same as if they had originally bought a 1000-fpm line. Kaiser, Fontana, on the other hand, is putting in a nominal 1000-fpm line now so expansion there will require installing additional units.

Quentin M. Bloom: You stated in your comparisons that several processes were existent. I think it is a healthy comparison to make. I believe that you posed one direct question, whether effective soaking time was about ten sec.

I have not analyzed our curve, in light of Mr. Mohri's work. It was published recently. I believe, however, that he considered the time from temperature down to 1100 F as total soak. Perhaps this represents something around ten sec., if I recall the curve. The need for soak, however, is a provocative subject. We have done considerable work on it and found from our studies that it was not needed.

Charles A. Turner: On the question of the requirement for soaking at annealing temperature, reference has been made to Mr. Mohri's paper wherein he established a minimum effective soaking time (time above 1100 F) of 25 sec to ensure a completely annealed structure. I would not dispute his results, but it is my opinion that they can only be considered reliable for the particular conditions and techniques of his laboratory test procedure.

For example, the strip temperature was recorded by sandwiching a thermocouple between two strip samples. This would, of course, double the heating and cooling time between 1100 F and the peak annealing temperature when compared with a single thickness being processed continuously.

Our pilot line testing, which preceded the production installation, amply proved that rapid heating (under four sec) to an annealing temperature in the range 1250 to 1300 F and immediately cooling to 800 F in a minimum time of 18 sec would develop a completely annealed structure meeting all the product requirements. Thus, in our production installations, the effective soaking time (time above 1100 F) is about eight sec. It is our opinion that soaking is only desirable where required to insure a uniform peak annealing temperature. As Mr. Bloom noted, with the heating of a single strand in one pass between our radiant panels, the strip reaches a uniform annealing temperature over its full width in seconds. With no soaking, recrystallization is complete following the aforementioned cooling cycle.

The benefits of holding for lowering hardness are so slight that we have chosen to ignore them in the interest of minimizing the number of loops in the line.

W. H. Swisshelm: The advantages listed for the installation described here are positive and persuasive. I might add that I think in general our results pretty much agree with his. However, as an operator of a single-pass, cup type radiant-fired unit, there are several questions I would like to ask. When an emergency stop is made, is full heat maintained on the retracted furnace, or is fuel input also reduced? What is the practice on resumption of operation? What is the sequence of strip movement, furnace replacement and tension control? Has any difficulty been encountered with strip trackage? If so, is it traceable to the laterally moving furnace? The initial line has been in operation approximately 16 months. Is there any evidence of deterioration of refractory, burner or burner cup so far? What type of atmosphere gas is being used and what is its analysis and dew point? Have any difficulties, such as dimpled strip, been encountered with accumulation on the hot rolls?

Quentin M. Bloom: Mr. Swisshelm's first question was whether full heat is maintained on the retracted furnace during an emergency stoppage. No, we automatically reduce the heat input to the furnace when it is retracted. In restarting we bring the furnace on when the strip is moving at approximately 250 to 300 fpm. The tension control varies, of course, according to gage but is reduced as the cold strip is heated, i.e. the strip tension is made slightly higher than normal when the furnace is brought on because the strip is cold. While the strip is heating up, the tension is gradually relaxed until it is brought to the point desired. It is then put on automatic control for subsequent operation.

His next question was about strip trackage traceable to lateral movements. Earlier we thought there was some effect. However, investigation revealed that our inconsistent effects were actually due to inexperienced crews. The crews now have the necessary experience, and I think we can say that the lateral moving furnace has no effect on strip trackage.

Mr. Swisshelm asked about the life of the refractory, the burners, the cups, etc. In regards to that, one line has been operating for about 16 months. I think I can say that there has been very little deterioration noticed so far. We had to use experience gained from other installations, in the same plant, similar to it but doing another process. It looks as though the life is somewhat over two years for the lining and the burner cups in this type of design. The burners are mounted in removable and interchangeable panels to facilitate inspection and maintenance.

The atmosphere gas that we are using is a hydrogen-nitrogen atmosphere. It consists of four per cent hydrogen and 96 per cent nitrogen. We are currently using 8000 cu ft per hr. That is the figure we started off with; we have never altered it. We do not know whether that is the lowest or the optimum point at

this time. The atmosphere gas is injected into the cooling sections with a minus 70 F dew point.

To date, in none of the four lines have we observed any indication of roll pickup and the associated dimples in the strip.

R. E. Noble: The author, in his case for low or moderate speed continuous annealing lines of maximum simplicity, has mentioned briefly some of the mechanical features of the line which contribute to its reliability and success. It may be interesting to make further mention of some of these features.

The lines are designed to operate with controlled strip tension throughout. There are no free or gravity loops and no provision for free loops. Storage of strip to allow continuous operation of the furnace at normal constant speed while starting a new coil at the entry end of the line and removing an annealed coil at the delivery end is provided by two identical looping towers, one near the entry end of the furnace and one beyond the delivery end. These towers each carry five idler rollers on the movable carriage which has a 50-ft vertical working travel. Thus there are in storage in one tower ten strands of strip of 50 ft length when the tower is fully extended providing a strip storage capacity of 500 ft.

When the line is running at normal annealing speed, No. 1 tower stands full of strip and serves to store strip for the furnace to draw on during the period when a new coil is being started at the entry end. The entry end can be temporarily speeded up to a maximum of 1170 fpm to quickly restore the tower to its running position. This is done by manual control of the strip speed throughout the entry end.

No. 2 tower stands empty ready to receive strip from the furnace during the time required to remove a coil at the delivery end. The tower is then restored to its empty or running position in the same way by a temporary manual speed up of the delivery end to a maximum of 1170 fpm.

The towers have adjustable gravity counterweights by which strip tension at these points is predetermined and set. The carriage can be pulled down by an auxiliary device to the bottom of its travel for ease in strip threading. There is a safety provision for checking its upward travel in case of strip breakage.

There are, in all, five main bridle or pinch roll units in the line, one on each side of each looping tower and one on the entry side of the cleaning section. Their pulls balance the preset tension in the towers and the tension unit and provide the necessary positive or negative pulls in the strip. Ordinarily No. 1 and No. 2 units at No. 1 tower pull forward, No. 3 and No. 4 units at No. 2 tower hold back, and the coil is wound at the delivery end against this backward pull. No. 0 at the entry end of the cleaning section is mainly a holding unit.

Of these five principal power units, four are pinch roll pairs, each pair driven by one motor or connected to one generator. The one bridle unit between the cleaning section and the No. 1 looping tower has two independently driven rolls, each roll having its own motor. The two rolls are unequally powered to conform to the tension build-up from one roll to the other.

An electrolytic cleaning section, which has tanks for vertical passes with scrubber and dryer units, follows the welder and precedes the bridle in front of the No. 1 looping tower. There are two pay-off reels at the entry end of the line and one delivery winding reel. Altogether, including the pinch roll and bridle roll units, there are 66 principal rollers in the line, 24 of which are driven by main motors or by helper motors and 42 of which are idle. The helper motors, of which there are 18, are needed principally to assist in threading. Of the 66 rollers, 14 are in the electrolytic cleaning section, 22 are in the two towers, 14 are in the furnace, and 16 are in bridle, pinch roll and tension units.

In a continuous processing line of this kind running without free loops, there is an advantage in being able to predetermine and preset strip tension at certain key points in the line. This is especially important at the furnace where the tension in the hot strip must be closely controlled. An air-loaded tension device at the entry end of the furnace provides means of establishing and maintaining the desired tension at this point. Thus the strip tension can be preset at three points in the line, at the entry to the furnace and at the two towers. The task of maintaining proper motor loads and speeds and suitable strip tensions at the pinch roll and bridle units thereby becomes much easier.

Frank Lanning: We have had some experience in continuous annealing. Your chart of the times for rethreading in the different sections of the line seems very high. The time for rethreading furnace breaks is much shorter in this type of furnace than it is in longer cooling sections. But the fact of the matter is furnace breaks are a very small per cent of the total number of causes of line stops. In fact, larger capacity lines have operated up to a year without having one in that section of the furnace. As far as looper and cleaner breaks are concerned, I know, from training operators during the startup of seven of these continuous strip lines, that breaks in a looper can be repaired in a matter of seven to 12 min. Breaks in a cleaning section can easily be kept down to an average of about 20 min with the proper threading equipment. Further, it can be cut down to ten min on an average with an experienced crew.

I would also like to know what strip tonnage is unannealed or scrapped during startup following a shutdown.

J. A. Ward: Our delays on tower breaks have not been as low as Mr. Lanning indicated. An average delay figure for breaks in the tower and cleaner would be approximately 40 min for both locations. We have had relatively few furnace breaks, and on these I would have to generally agree with the figures indicated in the author's paper. It should be understood that furnace breaks can present a wide range of delay time variables which result from the unexpected, such as strip hung up on the heating elements, damage to heating units and rolls, etc. It also depends on the success of threading the pilot cable, etc. We are still relatively inexperienced in the strand anneal operation and certainly look forward to improved performance on delays at this unit.

W. M. Bloom: I think we will all have to concede that different crews, incentive rates, and working conditions are responsible for the repair times varying as they do. ▲

TENTATIVE PROGRAM

AISE Spring Conference

AUSPICES OF ROLLING MILL COMMITTEE

THE STATLER-HILTON BUFFALO, N.Y.

APRIL 27, 28, 29, 1959

"The Swedish Type of Repeater Mills for High Quality Steels," by Erik Norlindh, Morgardshammars Mek. Verkstads AB, Morgardshammar, Sweden

"Applications of Roll Ragging," by Herman E. Muller, Superintendent, Roll Dept., Indiana Harbor Works, Inland Steel Co., East Chicago, Ind.

"Kaiser's New Hot Strip Mill," by Lawrence L. Freret, Chief Project Engineer, Kaiser Engineers, Div. of Henry J. Kaiser Co., Oakland, Calif.

"Application and Selection of Gear Type Spindles," by Fred H. Paddon, Manager, Engineering and Sales, Amerigear/Bliss Spindles, Rolling Mill Div., E. W. Bliss Co., Salem, Ohio

"The Use of Oil Film Bearings on a 12-In. Merchant Mill," by H. Stanley Baldwin, General Foreman, 12-In. Merchant Mill, Sheffield Div., Armco Steel Corp., Kansas City, Mo.

"Some Uses for Ultrasonics in Industry," by A. Dixon, Supervisory Engineer, Metals Joining Section, Headquarters Manufacturing Laboratory, Westinghouse Electric Corp., East Pittsburgh, Pa.

"High Speed—Rod Rolling," by Earle E. Chamberlain, Division Superintendent, Hot Mills, Cuyahoga Works, American Steel & Wire Div., United States Steel Corp., Cleveland, Ohio

"Fundidora de Fierro y Acero de Monterrey-Mexico—reports on their New Combination Merchant Bar and Rod Mill" by B. R. Wible, Engineering Consultant to Management, and A. Fernandez, General Superintendent of Rolling Mills, Cia. Fundidora de Fierro y Acero de Monterrey, S. A., Monterrey, N. L. Mexico

"Rod Cooling and Results Obtained (Scale Loss, Surface, Etc.)," by C. E. Youngblood, Johnstown Plant, Bethlehem Steel Co., Johnstown, Pa.

"54 Years of Operation of the First Electric Driven Reversing Mill," by Elmer I. Pearson, Assistant Chief Engineer and George H. Krapf, Division Superintendent, Power Production, South Works, United States Steel Corp., Chicago, Ill.

"Automatic Gage Control on Cold Rolling Mills at Dofasco," by N. D. Stephens, Electrical Superintendent, Dominion Foundries and Steel, Limited, Hamilton, Ontario, Canada.

"Application of Individual Drive Motors to Mill Table Rolls," by Anthony Jakimovich, Application Engineer, Metal Rolling & Processing Engineering, Industrial Engineering Section, General Electric Co., Schenectady, N. Y.

"Fire Cracking in Rolling Mill Rolls," by N. R. Arant, Technical Director, Roll Manufacturers Institute, Pittsburgh, Pa.

"Mathematical Aids to Determine Bar Spread and Reduction Rates in Rolling," by Louis Moses, Mill Engineer, Bethlehem Steel Co., Bethlehem, Pa.

"Republic's Bar Mill of Tomorrow," by D. E. Weaver, Superintendent, Finishing Mills, and H. E. Berg, Chief Engineer, Chicago District, Republic Steel Corp., Chicago, Ill.

"Safe Control of a Mixed Gas Distribution System without the Use of a Holder," by Burton D. Barns, Supervisor, Fuel and Utility Section, Plant and Production Engineering Dept., Steel Div., Ford Motor Co., Dearborn, Mich.

"High Head Alloy Slab Heating for Planetary Mill Rolling," by Oscar J. Zanatta, Utilities Engineer, Atlas Steels Limited, Welland, Ontario, Canada

"Continuous Annealing in Molten Sodium," by J. D. Keller, Partner, Associated Engineers, Pittsburgh, Pa.

OFF-THE-RECORD ROLLING MILL PANEL DISCUSSION
Flat Products

OFF-THE-RECORD ROLLING MILL PANEL DISCUSSION
Shaped Products

INFORMAL STAG DINNER—APRIL 28

INSPECTION TRIP
Atlas Steels Limited, Welland, Ontario, Canada, and the direct reduction plant of Strategic-Udy Metallurgical & Chemical Processes, Ltd., Niagara Falls, Ontario, Canada

STATIC CONTROL Provides Blast Furnace Automation

Selection of charging materials for single skip furnace is programmed . . . . the coke and water charging are completely automated . . . . control system informs scale car operator when and what to charge . . . . interlocking prevents dumping of the scale car until its load material is scheduled . . . . control relays were replaced by relatively maintenance-free magnetic core type static control elements . . . . system controls the operation of the skip hoist, small bell, large bell, revolving distributor, equalizer valve and stockline recorders.

"WHY STATIC CONTROL"

by Neal J. Behne,
Electrical Engineer,
Ohio Works,
United States Steel Corp.,
Youngstown, Ohio

THIS paper covers the installation of an automatic charging system for No. 4 blast furnace at the Ohio Works of the United States Steel Corp. in Youngstown, Ohio. This is a single skip furnace. The charging system designates the ingredients to be charged into the furnace in accordance with a preset program by properly controlling all of the furnace drives that charge this material.

The material charged into the furnace consists of coke, water and scale car materials such as ore, stone and scrap. The charging of coke and water is completely automated. Unfortunately, it is impractical at this time to automate the selection and loading of the scale car materials. However, this charging system does keep the scale car operator informed at all times about which material he is to load and when to dump it into the skip car. The system also prevents dumping the scale car until this class of material is scheduled.

In addition to selecting the proper materials to be charged, the system controls the operation of the skip hoist, the small bell, the large bell, the revolving distributor, the equalizer valve and the two stockline recorders. When scale car material is to be charged, the scale car operator must start the skip. Under other conditions the skip is started automatically.

This charging system is the first automatic blast furnace charging system to be installed at the Ohio Steel Works. All known program control systems were studied before a method was selected. The use of motorized limit switches for this purpose is well known in the industry. A system using telephone type stepping relays has also proved quite successful. However, even in its most simplified form, a modern automatic blast furnace program control system is quite complicated. If a fault develops, it is difficult to locate. Limit switch contacts do wear and burn. So do the contacts on relays. Relays are very susceptible to atmospheric conditions.

It must be remembered that outage time on a blast furnace may result in serious loss of production. Therefore, it is imperative that in designing a modern blast furnace control system that the most reliable equipment available be selected.

Because control system relays, with their many moving parts, are one of the greatest sources of trouble it was decided to eliminate as many of these as possible from the system. Hence the use of static control devices began to get serious consideration. At that time static control devices were very new on the market. Their biggest application had been in the machine tool industry. To our knowledge they had no real test in heavy industry. However, investigation revealed that they would be just as reliable in a steel mill as in the machine tool industry. These devices are completely static—they have no moving parts. There are no springs to break or contacts to wear or burn. There are no screws to fall out because of vibration. There are no adjustments to be made. At this time the model on the market had all components mounted on a printed circuit board with just a spray varnish for protection. It was felt that they were not adequately protected against physical damage or atmospheric conditions. However, a new design was to be completely encapsulated in plastic with only the metal connection tabs brought out.

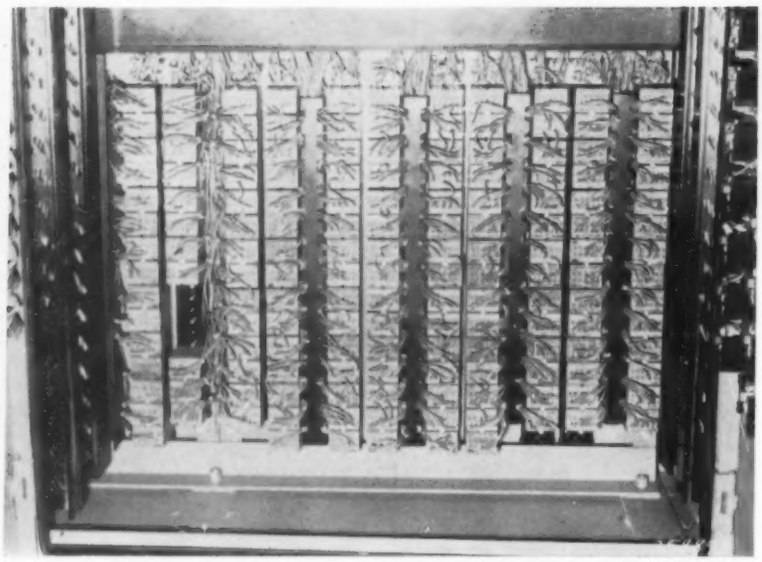


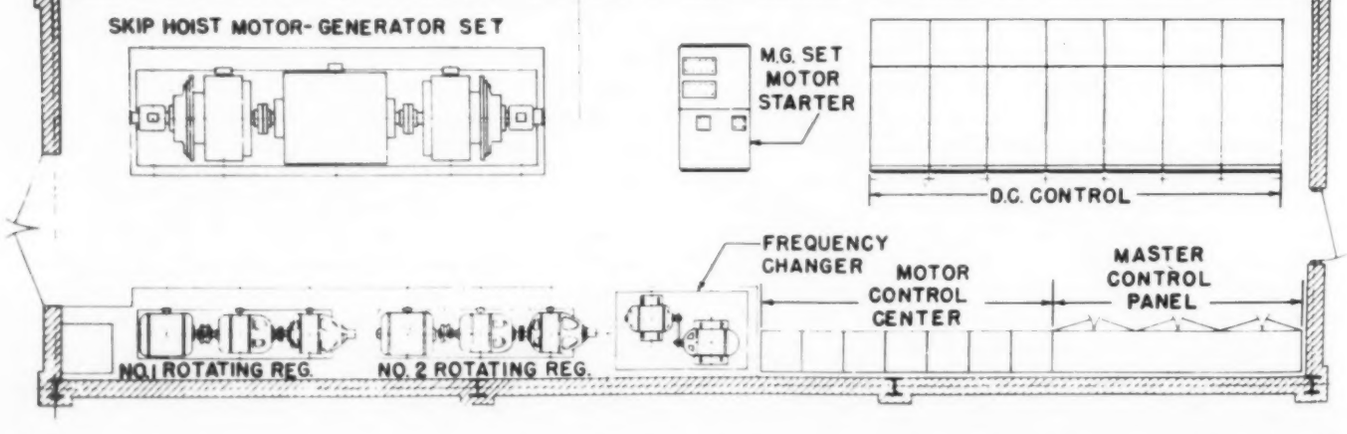
Figure 1 — This closeup shows the magnetic core type static control modules.

This removed the major objection to the use of static control. Figure 1 is a closeup of one of the static control cabinets showing the modules in detail.

There was another problem to consider, that of space for this equipment. The Ohio Steel Works is an old mill, and like all older mills is very congested. The blast furnace area is about the most congested area of all. In rebuilding the No. 4 blast furnace, the skip hoist control was converted to adjustable voltage. This meant finding space for a motor-generator set, rotating regulators, and their associated control equipment. The skip hoist house is located about 70 ft above ground level. This was a very unsatisfactory location for control equipment from a maintenance viewpoint. This had been the location of all the control for the bells, distributor, stockline recorders, and skip hoist. We had to find additional space for this control. We decided to build a new motor-generator house for all of this equipment. The only space available allowed construction of a building approximately 16 by 50 ft. Figure 1 is a layout plan of this building. At the top left note the motor-generator set, and on the bottom left, the two rotating regulators. In the center is the starting equipment for the 500-hp, 2300-v motor driving the two adjustable voltage generators. In the upper right are the d-c control equipment for all of the d-c drives involved in the furnace charging system including the skip hoist. These boards contain only main contactors, knife switches and fuses. There are no relays except for undervoltage and overload protection. All other relays have been eliminated by use of static control. Also mounted on this panel are memory type fault finders which monitor all protective equipment such as undervoltage relays, overload relays, emergency stop buttons, etc. In the center bottom is the motor control center containing starting equipment for the coke system drives, the rotating regulators, water valve, and miscellaneous a-c drives. In the lower right hand corner is the master control panel. This panel contains all of the static control devices for the system. On the doors of this panel are mounted all necessary equipment to set up the program together with indicating lights to follow every operation taking place at any one time. The floor space taken by this master control panel is 20 in. by 10 ft. This is less than half the space required by other systems. From this layout it can be seen that additional space was not available.

The steps that lead up to having coke available for charging is a story in itself. This system has two complete coke systems capable of operating independently or together. Each coke system consists of three normal coke bins, one emergency coke bin, a coke conveyor, a coke screen, and a weigh hopper complete with scale and printer. Under normal operations the weigh hopper is filled from each of the three coke bins in turn. However, any of the bins can be cut out in case the bin is empty, frozen or if trouble develops on the coke bin feeder. If the hopper does not fill in a preset time, that bin is automatically bypassed and a signal sent to the scale car operator that that bin is not functioning. It is possible to cut out any one normal bin or to cut out all three bins and transfer to the emergency bin. When the emergency bin is used, unscreened coke is dumped directly into the weigh hopper. The skip car is filled either by a full hopper from alternate sides or a half hopper from both sides. This selection is made on the master control panel. To obtain this flexibility in the coke system by means other than static control would

Figure 2 — A new motor-generator and control house was built. In it are the main adjustable voltage motor-generator set, its two rotating regulator motor-generator sets, its drive motor starter, the d-c control equipment which contains no relays except the ones for overvoltage and undervoltage protection, and the motor control center for the coke system drives and their rotating regulators.



require a large number of relays. This would require a great deal more space and would be considerably less reliable.

In conclusion, the advantages obtained by use of static control are as follows:

1. Longer life, increased reliability and considerably less maintenance due to the static nature of these devices.
2. Elimination of the adverse effects of corrosive atmospheres on standard control components.
3. Simplification of circuitry required for memory and counting. This permits retention of count during power outages.
4. Considerable saving of space which, in this case, is critical.

"STATIC CONTROL FUNDAMENTALS"

by H. C. Diener, Jr.,
Control Engineer,
Westinghouse Electric Corp.,
Buffalo, N. Y.

SOME of the basic reasons why the United States Steel Corp. selected static control for the system to be used on the automatic blast furnace programmer has been presented. The three basic parts of any control system are:

1. Sensing devices.
2. Intelligence devices.
3. Power handling devices.

Perhaps the little three-lettered work SIP will help keep these basic parts in mind. S stands for sensing, I stands for intelligence, and P stands for power.

Sensing devices, of course, include limit switches, pressure switches, flow switches, etc. Intelligence devices previously included industrial control relays and stepping switches. Now magnetic logic elements must also be included. Power handling devices include motor starters and contactors.

Generally, the sensing devices monitor conditions on the system. The intelligence devices receive this information, interpret it, and initiate necessary action. The power devices control high power levels for performing the subsequent functional or corrective action.

As indicated in the foregoing statements, magnetic logic elements are associated with the intelligence portion of the control system. To obtain a complete and concise idea of how these elements are applied, answers to the following questions must be obtained.

1. What is the nature of magnetic logic elements?
2. How are they put together into a sequential circuit?
3. What power levels are required for their operation?
4. What sort of transition devices are required between the logic elements and power handling devices?

NATURE OF THE LOGIC ELEMENTS

Magnetic logic elements rely on the rectangular hysteresis loop of certain magnetic materials for their operation. Magnetic materials possess a hysteresis loop, or B-H curve, which describes the variation of magnetic flux density with magnetic field intensity. The loop for steel used in most rotating machinery is shaped somewhat like the letter *S*. The magnetic saturation of these steels is gradually approached over a curved portion of the loop known as the knee. Rectangular loop material saturation is sudden instead of gradual. Thus, the material is either saturated or not saturated, never partially saturated. The knee of the hysteresis loop is, thus, replaced by a corner.

In the nonsaturated zone, a coil wound on such a material has a high impedance. In the saturated zone, this coil has a low impedance. Now a pair of relay contacts have a high impedance, infinity, when opened and a low impedance, zero, when closed. It is possible to build a saturable reactor circuit using the rectangular loop cores for the relaying functions. As previously stated, this is done by controlling the saturation of the cores. Magnetic logic elements are such circuits. Beside the rectangular loop cores, silicon and selenium rectifiers and resistors are required. Such a device can perform the relaying function without moving mechanical parts or arcing contacts. Its life is dependent, not on the number of operations, but only on the very gradual chemical changes to which all matter is subjected.

SYNTHESIS OF LOGIC CIRCUITRY USING LOGIC ELEMENTS

Study of typical sequential relay control reveals four basic relay functions from which sequences are made. These are:

1. Contacts in series.
2. Contacts in parallel.
3. Normally-closed contacts.
4. Electrically sealed-in or mechanically latched-in contacts.

Virtually all sequential circuits are composed of combinations of these contact configurations.

In order to utilize the rectangular hysteresis loop characteristic it is necessary to build *and*, *or*, *not* and *memory* functions. Figures 1 through 8 illustrate how these logic functions can be used to replace the basic relay functions.

Figure 1 is a typical relay circuit illustrating contacts in series. This corresponds to the *and* element used in logic element nomenclature. In order for relay D to be energized, contacts A and B and C all must be closed, i.e., signals A and B and C must be present in order for output D to appear. Figure 2 shows the logic element symbol for the *and* function. The block symbol is taken to represent the network of magnetic core, rectifiers and resistors. In order for the output to appear, inputs A and B and C must all appear simultaneously.

Figure 3 shows the typical relay circuit illustrating contacts in parallel. Here, the closing of any one of the contacts, A or B or C, will energize relay D. This corresponds to the *or* element used in logic element nomenclature. Presence of A or B or C causes signal D to appear. Figure 4 shows the logic element symbol for the *or* function. The symbol itself represents the network of components. Presence of any one or more of the inputs causes the output to appear.

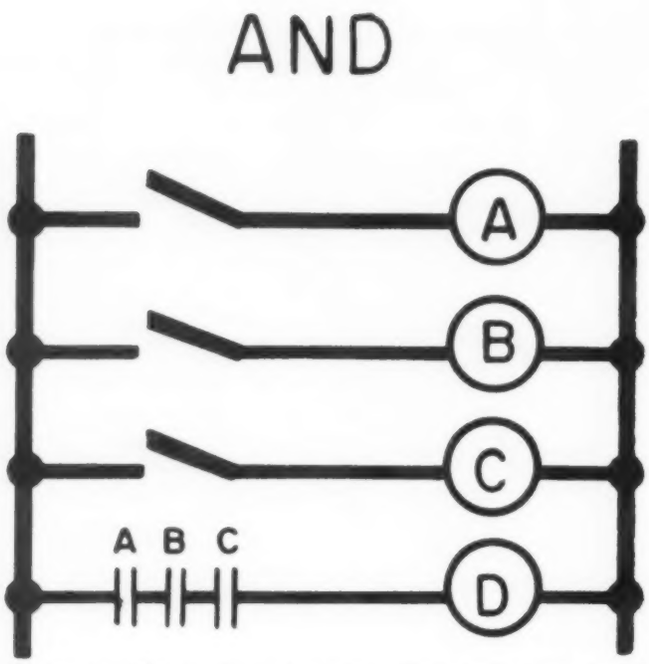


Figure 1 — This is the relay equivalent circuit for an *and* function.

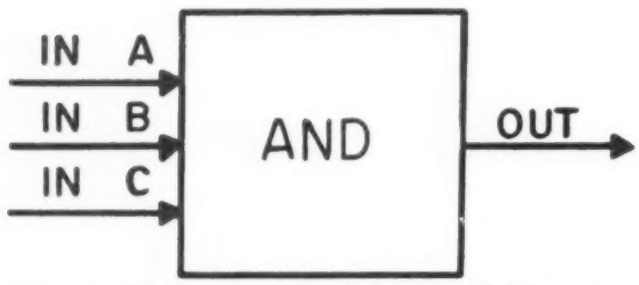


Figure 2 — This is the logic element symbol for an *and* function.

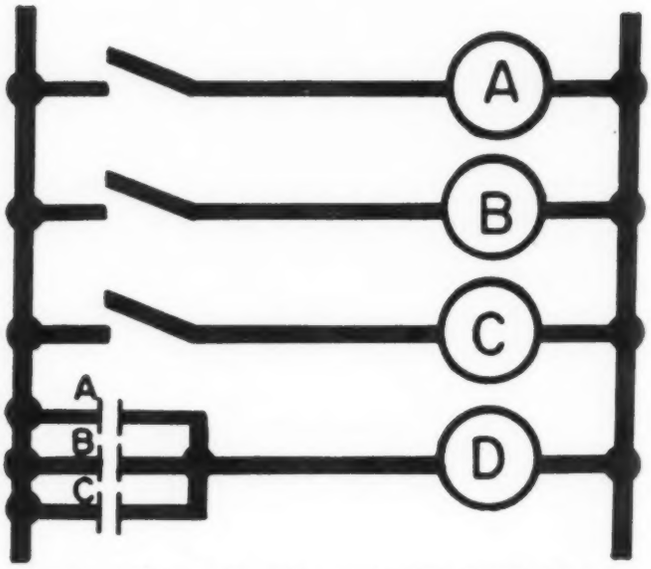


Figure 3 — This is the relay equivalent circuit for an *or* function.

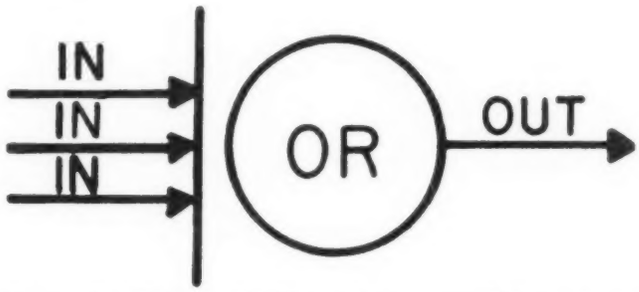


Figure 4 — This is the logic element symbol for an *or* function.

Figure 5 shows a typical relay circuit employing a normally closed contact. When signal A is present, signal B is absent. When signal A is absent, signal B is present. Signal B is not the same as signal A. This corresponds to the *not* logic element. Figure 6 shows the logic element symbol for the *not* function. Again the symbol represents a network of components. Presence of an input signal causes the output to disappear. Absence of an input signal causes the output to appear.

Finally, Figure 7 represents an electrically sealed-in relay. When contact A is made momentarily, or otherwise, relay C is energized and its contact closes sealing in around A. After contact A is opened, relay C remains energized. Contact B is a normally closed contact. When it is opened, relay C is de-energized. It can be said that the circuit remembers that contact A has been closed until such time as contact B is closed. Thus, it is known which occurred most recently, A or B. This function corresponds to the *memory* logic function.

Figure 8 shows the symbol of the *memory* function. Momentary presence of the upper input A causes the circuit to put out a signal until such time as the lower input momentarily appears. Normally, this circuit will not necessarily return to its most recent state in the event of power failure and subsequent restoration. An accessory is available which permits the unit to so operate, however, in such a mode. It would correspond to a mechanically latched-in relay instead of the electrically sealed-in relay.

In addition to the above, a time delay element is available for performing timing functions. By thinking in terms of *and*, *or*, *not* and *memory* functions, sequential circuits can be synthesized to perform the same functions as relays perform in information processing.

POWER LEVELS

The logic elements require only about 12 milliwatts for each input signal. They are capable of about 120-milliwatt output. This is at voltage levels of about 12-v half-wave rectified direct current. A special power supply is required for supplying the necessary bias and power voltages from industrial power systems of 230 or 460 v. The system is limited to 60-cycle operation only.

TRANSITION DEVICES

It is desirable to operate conventional sensing devices at 115 v. This is a reasonably safe voltage but high enough to give good contact reliability. Because low signal voltages are required, a step-down device is used with each input signal. The low power switching capabilities of the static system also require a power amplifier in order for the system to energize

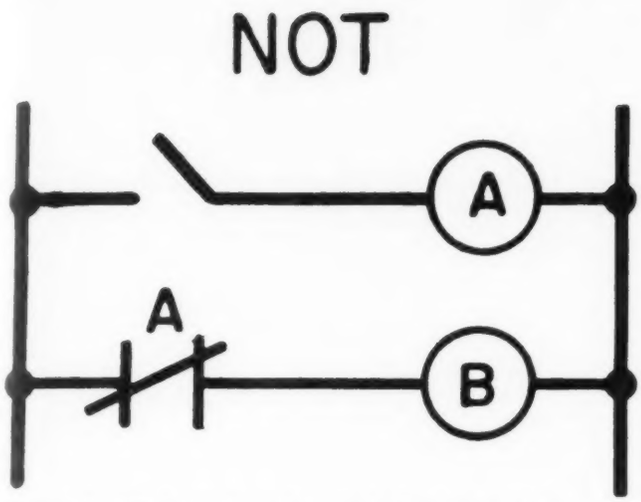


Figure 5 — This is the relay equivalent circuit for a *not* function.

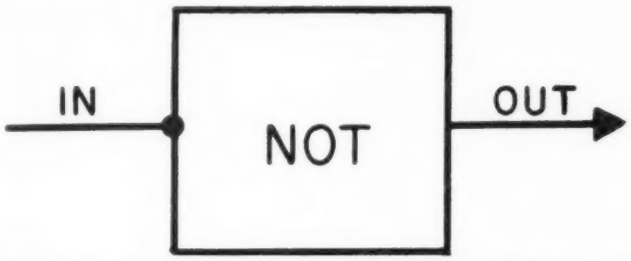


Figure 6 — This is the logic element symbol for a *not* function.

motor starters and contactors. Sufficient power is available for controlling a doubler type magnetic amplifier. These amplifiers are available in designs especially suited for driving by logic elements.

APPLICATION AND DESIGN

The application of logic elements to the design of a blast furnace programmer tends to simplify, rather than complicate, both the design procedure and any in-service trouble-shooting procedure. Our normal human mental process is naturally built to operate on an *and-or-not-memory* basis. The next time you perform a simple operation such as starting your car, lighting a cigaret, or mixing a drink, analyze your thought train. You will agree that the *and-or-not-memory* concept appears. Your mental pattern can very easily be set down in terms of the logic functions. It would not be quite as natural to think of your thought patterns in terms of relay contact networks. For this reason, once a little practice is obtained in the basic concepts, the logic element system is substantially simpler to follow than the relay contact network by both engineers and maintenance personnel.

"APPLICATION OF THE STATIC CONTROL"

by J. Raymond Erbe,
Metal Working Engineer,
Westinghouse Electric Corp.,
East Pittsburgh, Pa.,

THE two preceding authors have elaborated on the advantages of programming blast furnace

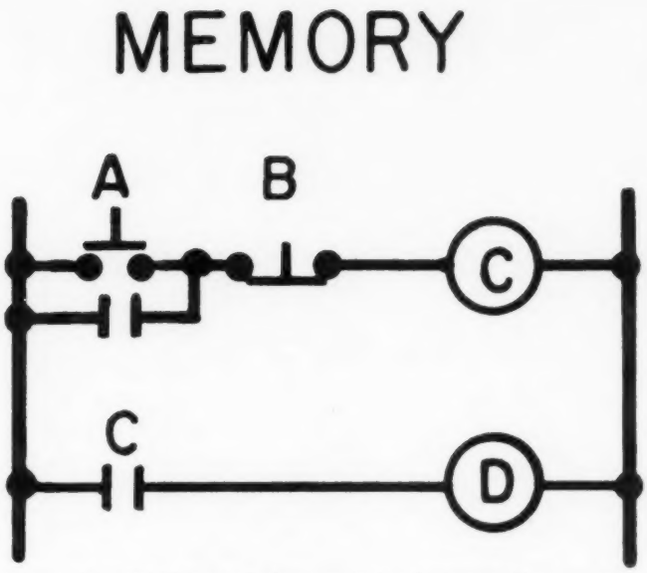


Figure 7 — This is the relay equivalent circuit for a *memory* function.

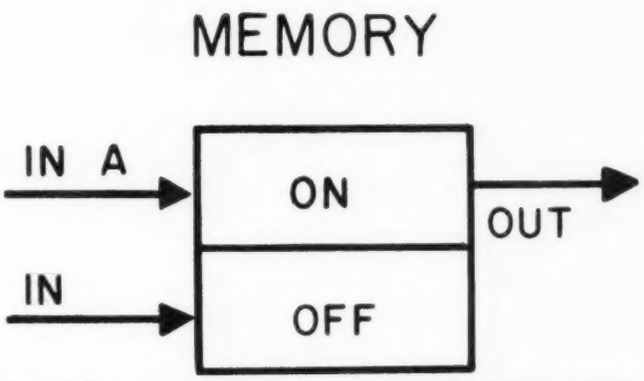


Figure 8 — This is the logic element symbol for a *memory* function.

operation, compared the various methods of programming currently available, explained the reasons why a static programmer was selected for this furnace, explained what it really is, and discussed some of its design problems.

This paper discusses some of the problems of the complete application, predicts some of the future possibilities of static control programming, points out some other applications in the steel industry, and mentions other types of static control currently being applied in the steel industry.

Because all of the material going into a blast furnace, for reduction into pig iron or for assisting in the reduction process, must be charged through the top of the furnace by the skip hoist, this drive must be as reliable and maintenance free as it is possible to make it. This furnace, as is common for all blast furnace skip hoists built prior to 1948, was equipped with a d-c constant potential skip hoist drive. Such a drive requires the use of large main line contactors and in some cases where higher speed operation is required to meet the charging cycle the use of field accelerating and decelerating relays as well. Since a furnace of any appreciable size requires one skip load of material per min to maintain normal operation of the blast furnace, it can readily be shown that the hoist must deliver between 1,250,000 and 1,500,000 skips of material for each blast furnace

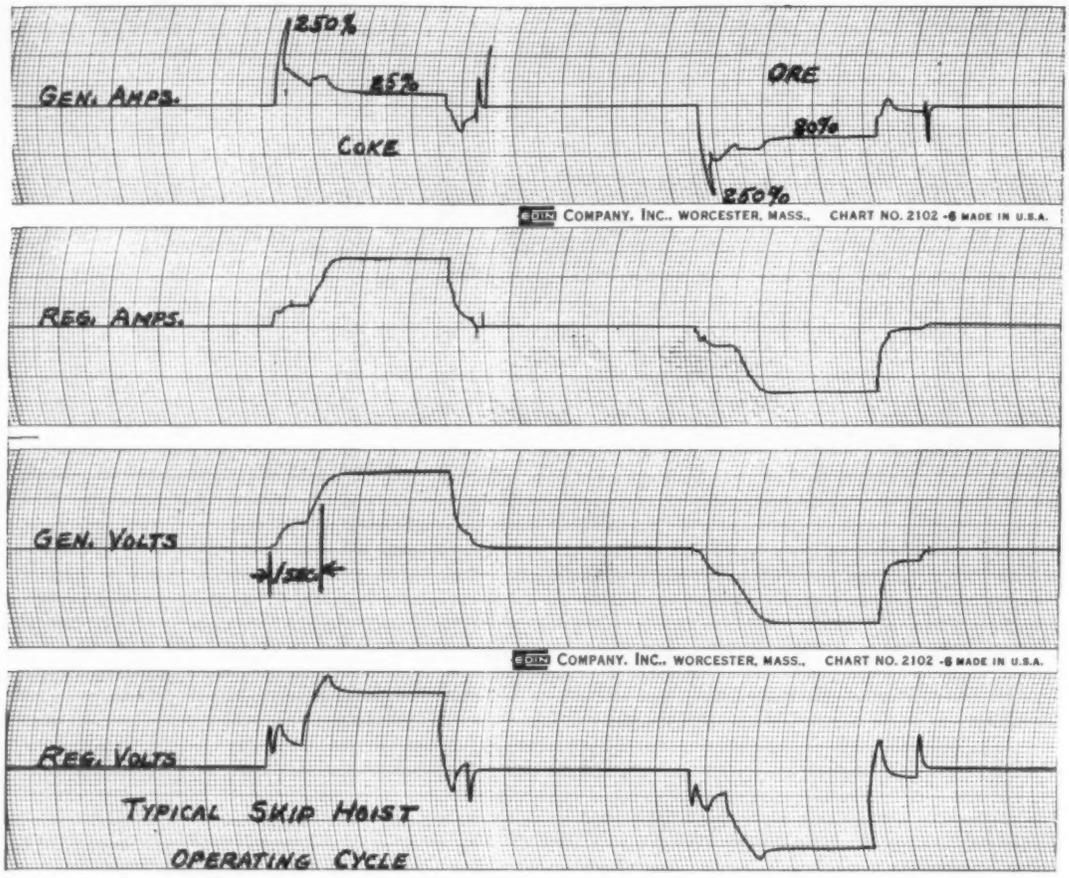


Figure 1 — These curves are from an oscillograph test of a typical adjustable voltage skip hoist drive. Notice that the curves do not have the surges that a constant potential drive has.

campaign. Since many of these contactors and relays operate more than once for each skip hoist cycle, it is understandable why they should require considerable maintenance during any campaign. Because of this, the decision was made in rebuilding this blast furnace to replace the skip hoist drive with a regulated d-c adjustable voltage drive which would eliminate all of the main line contactors and most of the relays. With a drive of this type it is possible to use current limit control for the acceleration and deceleration. This permits the maximum rate possible consistent with the commutation ability of the motors and generators. Because the speed of such a drive is accurately regulated, it is possible to more accurately position the stopping points of the skip hoist. This, in turn, minimizes unnecessary stresses imposed on the hoist cables. Figure 1, taken from an oscillograph test of a typical adjustable voltage skip hoist drive, shows that the hoist was accelerated to full speed in approximately 1.2 sec with approximately 250 per cent of full load motor current; and that the full speed running load when charging coke was approximately 25 per cent of full load motor current, and when charging ore the running load was approximately 80 per cent of the full load motor current. It should be noted from these curves that all changes in speed and load are made without severe surges, such as the ones evident with a constant potential drive. The result is more efficient use of the drive equipment without, in any way, abusing the equipment. As a result, a drive of this type will require considerably less maintenance and will have greater reliability than a corresponding constant potential d-c drive.

When it was decided that static control would be used for automatically programming the operation of this furnace, it was also decided that the coke system would be automated and that the coke normally would be charged without any assistance from the operator. This makes the time previously used by the operator for supervising the loading of coke into and the starting of the skip available to the scale car operator for his normal duties, refilling the scale car with stone and ore so these materials are, available for charging the skip with a minimum of delay.

The coke system was built as shown in Figure 2. Two weigh hoppers were used. They were arranged so that coke could either be charged by weight or by volume with all of the coke for a particular skip coming from either hopper or one-half of the load coming from each weigh hopper. Each weigh hopper is filled from any of three bins by means of a conveyor which passes the coke over a shaker screen to eliminate the coke breeze. In addition, each weigh hopper has an emergency bin which can be used in case the coke sticks in any of the normal bins, the bins are empty, the coke conveyor should fail, or the shaker screen should fail. It is believed that this system has sufficient flexibility to cover any operating condition or contingency which might arise thus providing the reliability required for maintaining uninterrupted blast furnace operation.

It was decided that static control should program and control the operation of the coke bins, coke conveyors, coke screens, weigh hoppers, hopper gates, and water addition to any skip. The control interlocks with the scale car and controls the revolving distributor, the small bell, the large bell, the equalizer valve and the stock line recorders. A block diagram of this control is shown in Figure 3. This control was built to

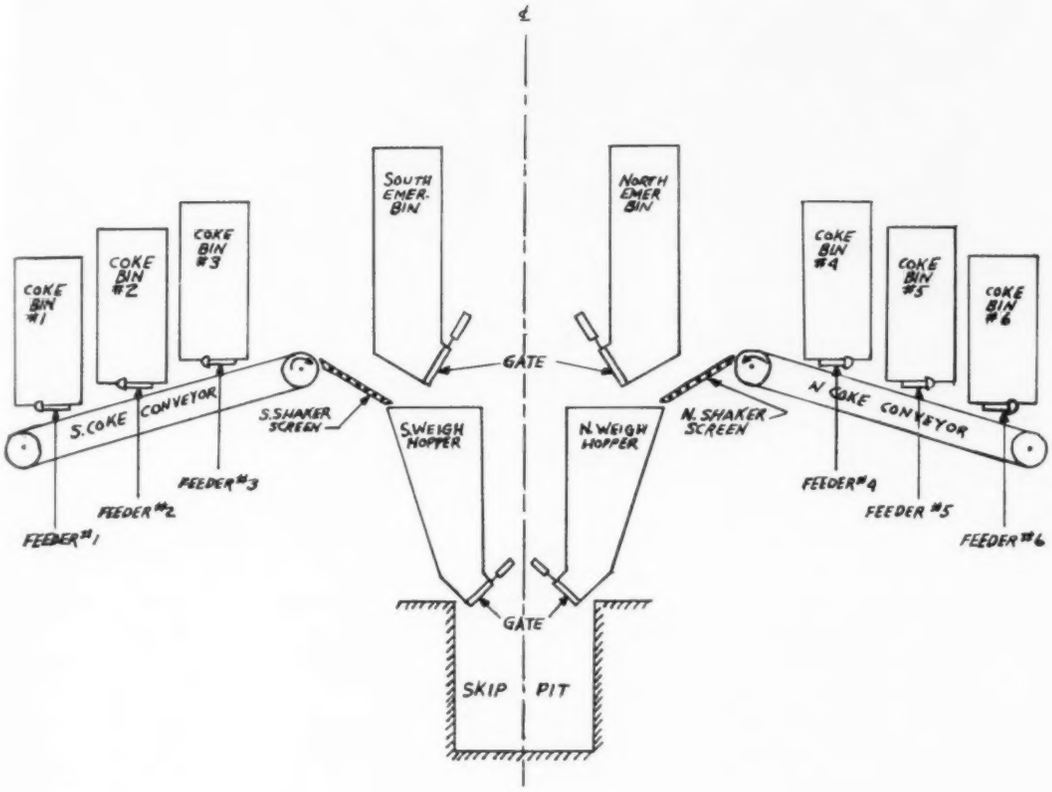


Figure 2 — This arrangement diagram is of the blast furnace coke system.

program either round A or round B, each consisting of a maximum of 10 skips, with any skip load being scheduled for ore, stone, coke, or water. Either ore or stone will be charged into the skip from the scale car by the scale car operator. Interlocking is provided, however, so that the operator cannot add ore or stone from the scale car to the skip when coke had previously been scheduled. When either ore or stone is scheduled and upon completion of filling the skip, the scale car operator will start the hoist.

A selector switch is provided so that the furnace can be charged according to the program of round A, according to the program of round B, according to the program of round A plus round B, or according to round AB as required to best meet the charging requirements. Whenever either round A or round B has been selected, the charging will proceed in accordance with the preselected schedule of material set up for that particular program. At the completion of the round the control will operate the large bell to discharge the material into the furnace and also change the distributor angle.

If round A plus round B has been selected, the skips of material scheduled in round A will be charged, the large bell will be operated, and the distributor angle will be advanced. Then the skips scheduled for round

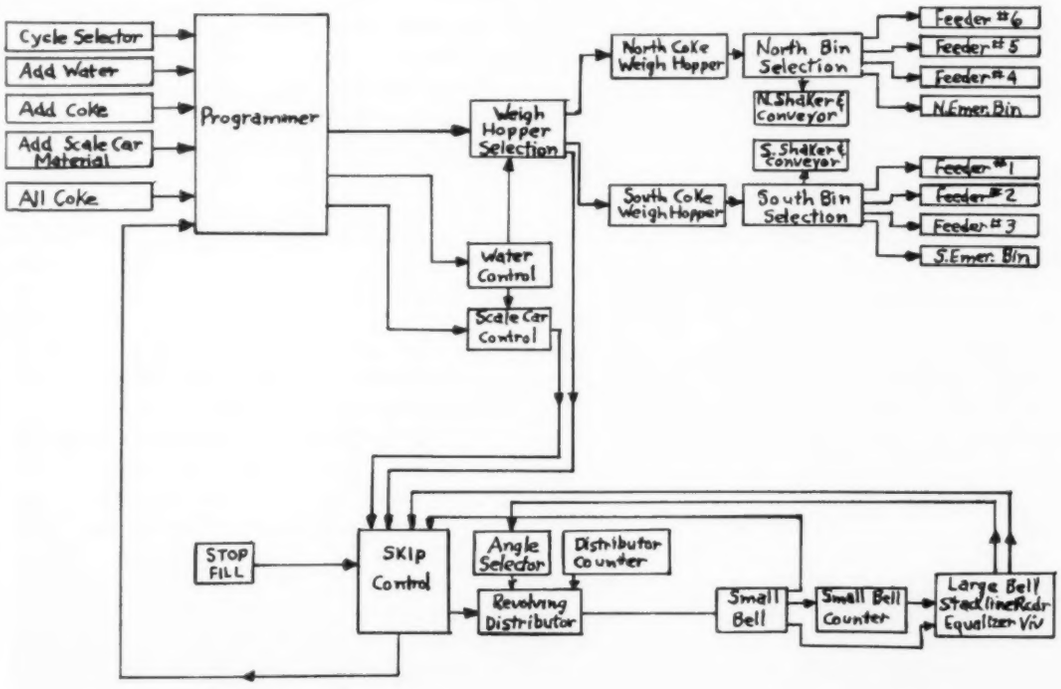


Figure 3 — This is the block diagram of the static control that programs and controls the operation of the coke bins, coke conveyors, coke screens, weigh hoppers, hopper gates, etc.

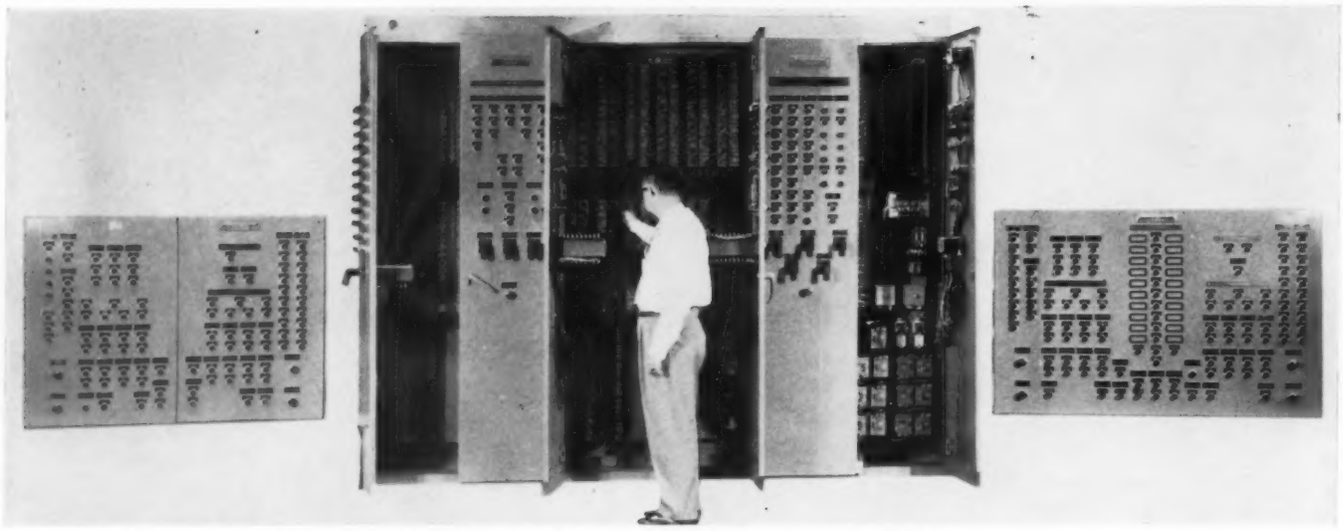


Figure 4 — The center cabinet contains 900 magnetic core type static control modules.

Figure 5 — The static control operation is controlled and indicated by pushbuttons, control switches and indicating lights on the doors of the center cabinet.

B will be charged, the large bell operated, and the distributor angle advanced following which the program will return to round A and so on. When the program is set up for round AB operation, the skips as scheduled in round A will be charged followed by the skips scheduled in round B following which the large bell will be operated and the distributor angle changed.

The control is arranged so that, under any of these four methods of operation, extra skips of ore, stone, or coke and extra additions of water can be added without changing the preset program. As the volume between the small and large bell is sufficient to accommodate only a maximum of 11 skips of material, two separate counters are employed in the static control. The first counter counts only the skips in the programmed round, and at the completion of the programmed count operates the large bell and the revolving distributor. The second counter counts every skip, whether programmed or not, and forces an operation of the large bell after eleven skips of material have been sent to the top of the furnace regardless of whether the round has ended or not. This counter therefore insures that no more material will be deposited on the large bell at any one time than the furnace top has room to accommodate. Both of these counters are reset at the completion of the programmed cycle.

In addition, static control will raise the stock line recorder probes before each operation of the large bell to prevent damage to the probes. Following the large bell dump, the probes are again lowered into the furnace to record the level of the stock line. Interlocking is provided so that if the stock line recorder indicates the furnace is full, a suitable indicating light will be lit; and the next skip load of material will be stopped at the slowdown just outside the dumping horns. The skip cannot be restarted until sufficient space in the top of the furnace becomes available.

Figure 4 shows the magnetic core type static control with the front doors open displaying most of the approximately 900 static control modules which comprise it. Figure 5 shows this same control with the doors closed. The round selection and the desired makeup for round A and round B are selected on the door at the extreme left. The operation is indicated on the next door to the right by indicating lights that show the type of material, material to be added when extra skips are

called for, position of the skip on the incline, whether or not the bells are open or closed, and the method of charging coke selected. The next two doors provide the selection and indication for operating the north and south coke systems and the position of the various hopper gates. The remaining two doors contain the pushbuttons, control switches, and indicating lights for controlling the other auxiliaries associated with the furnace such as fans, regulator motor-generator sets etc. This control cabinet is located in the motor-generator set and control room and is used for setting up the desired program of operation.

The operator's control station, shown at the right hand side, is located near the skip hoist pit facing the scale car. It is located so that it can be conveniently operated by the scale car operator. The other operator's control station is located back-to-back with the scale car operator's station and is used for manual control of the skip hoist charging and manual operation of the other equipment. Indicating lights on both of these stations show what material is to be charged into the next skip as well as the progress of the complete cycle of operation at any time. Three methods of operation are provided for on the manual operator's station. The first method is with all functions except the emptying of the scale car being automatically programmed and controlled by the static control. The second method is a semi-automatic method in which the indication of the program is obtained from the master program control, but the initiation for each step of the cycle is obtained from a pushbutton on the manual operator's control panel. The third method of operation is for maintenance in which all functions are manually operated without going through the static control equipment. It is believed that this control provides as complete automation as any which have been built for the control and operation of a blast furnace. It has provision for meeting almost any situation which might arise under normal operating conditions.

It is believed that in the not too distant future new blast furnace plants will have stockyards that will be entirely conveyorized and have means for making automatic analyses of the ore and other materials, computing the proper mix of these materials, and automatically feeding them to the skip hoist. The result will be a complete charging operation that could be set up for any particular grade of iron by means of suitable punched cards.

It is interesting to note that magnetic core type static control has already been supplied for automatically controlling a sintering plant. Since a sintering plant essentially consists of bins, conveyors, fans, etc., which are started in a definite sequence, operated with definite relationships being maintained between the various drives and stopped according to a fixed pattern; it becomes an ideal application for a logic control. This sintering plant control functions in a manner very similar to that used for the coke systems on the blast furnace charging equipment.

Another interesting application for static control, which has been given some consideration, is controlling soaking pit covers from the pit cranes. In connection with this application some thought has been given to controlling the cranes from the soaking pit floor and to using static memory devices for retaining the information as to which ingots were charged in which pits and for scheduling their withdrawal either in the same order or in the reverse order.

While on the subject of static control and automation of steel mill processes, it is believed that some mention should be made of a newer type static control equipment which has been, or is being, installed on five mills. In contrast to static control that fundamentally uses magnetic cores for switching purposes, the new type static control uses transistors for its switching and memory functions. Figure 6 shows a typical block diagram for the transistor type static control of a screwdown drive. All of the information for the screwdown to roll an ingot into a slab or bloom is punched into an IBM card. This card is then placed in the card reader which stores the information in the storage element. When the screwdown control is initiated either by the operator or other means, the control obtains the proper information from the storage element, operates the screws to the proper position and stops to await completion of the rolling pass. Then it obtains

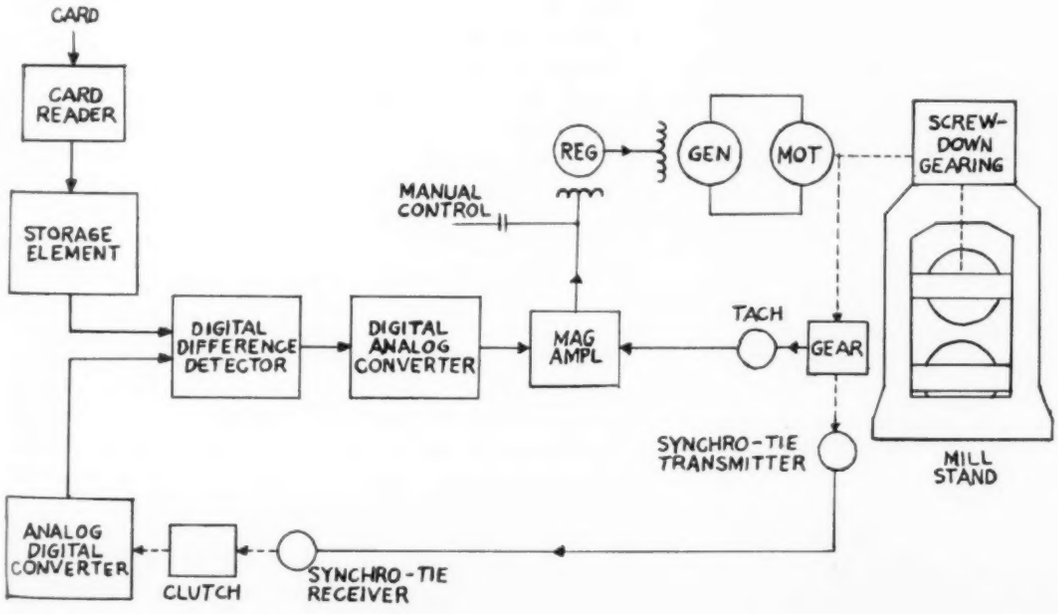


Figure 6 — This block diagram is of a transistor type static control programmer for a mill screwdown control.

the next bit of information and adjusts itself for the succeeding pass. This continues until the rolling schedule is completed.

In conclusion, it is believed that automatic control of the equipment and processes, such as has been described, will result in reduced maintenance with increased reliability of operation, a better product with more uniform characteristics, greater yield from the processes with reduced cost, and elimination of error by operators.

Discussion

PRESENTED BY

J. E. ORAM, Industrial Engineering Section, General Electric Co., Schenectady, N. Y.

P. A. TRAVISANO, Manager, Heavy Mill Systems Engineering, Industry Control Dept., General Electric Co., Roanoke, Va.

J. RAYMOND ERBE, Metal Working Engineer. Westinghouse Electric Corp., East Pittsburgh, Pa,

J. E. Oram: We have had in operation, since 1952, two automatic blast furnace charging controls which are functionally similar to the system described in these papers, including automatic coke charging. Since this equipment was manufactured before the advent of static switching techniques, miniature type relays and stepping switches were used to perform the complex interlocking and sequencing functions. The critical devices were designed to be of plug-in design. Reports from the user indicate very excellent performance with practically no relay maintenance required.

Nevertheless, we concur with the authors that a static switching approach to blast furnace programming and control is sound. We wholeheartedly recommend static switching for such applications. We are also in agreement that the time is not too far distant when completely automatic blast furnace charging will be a reality.

As a matter of fact, we have proposed an automatic conveyorized system which would completely automate the charging system and control proportioning and charging of all of the raw materials. Furthermore, we feel that in the not-too-distant future, data processing and computing will be used to evaluate operation and perhaps partially close the loop to control operation of the blast furnace. One of the big obstacles to this now is the lack of a definition of the relationships between the literally dozens of process variables and their effect upon the final product, pig iron. Probably, the first step in closing the loop is completely automatic charging used in conjunction with data recording so that this area of the operation will be well defined and documented. This, then, would provide a solid base for a complete automation program for the blast furnace.

We have just recently put into operation a relay type charging control in Holland, and another is due to be installed in July, 1958 in Belgium. The latter equipment includes several new features. The basic charge is made up of coke, ore and scrap with practically no stone charge and a very high scrap charge. The control system functions to automatically charge both coke and scrap. In addition, provision is made for changing distributor angle of rotation either at the end of each round or after a selected number of skips at each particular angle. This system, I believe, is one of the most automatic blast furnace charging systems to date and is one additional step in the progressive automation of the blast furnace.

Figure 1 — This static switching unit, a multi-function unit, will provide up to 21 combinations of relay interlock arrangements.

P. A. Travisano: The development of static switching techniques offers a new and valuable tool that becomes more attractive as the control is extended to include more functions and is made more completely automatic. We have adopted the use of multi-function static switching units to provide the flexibility required by steel mill systems to accommodate changing operating conditions.

The static switching unit shown in Figure 1 is called a multi-function unit since it will provide up to 21 combinations of relay interlock arrangements. Thus, a single unit can perform numerous combinations of the *and*, *or*, *not* etc., logic functions. This design allows considerable circuit modification without the use of additional units. The monitor light provides a visual indication that the unit is either on or off. A family of eight such units are available to accomplish all of the normal control circuitry. Each of the units is individually colored for ease of maintenance inspection.

Not only is it desirable to replace the sequencing relays with static units, but it is also desirable to eliminate interlocks in the regulating circuits. One of the features of our equipment is a grey colored isolated switch unit that is used for opening and closing regulator field circuits. The normal logic units are not suitable for this purpose. This unique unit is very important if the number of relays is to be reduced to an absolute minimum for adjustable voltage control systems.

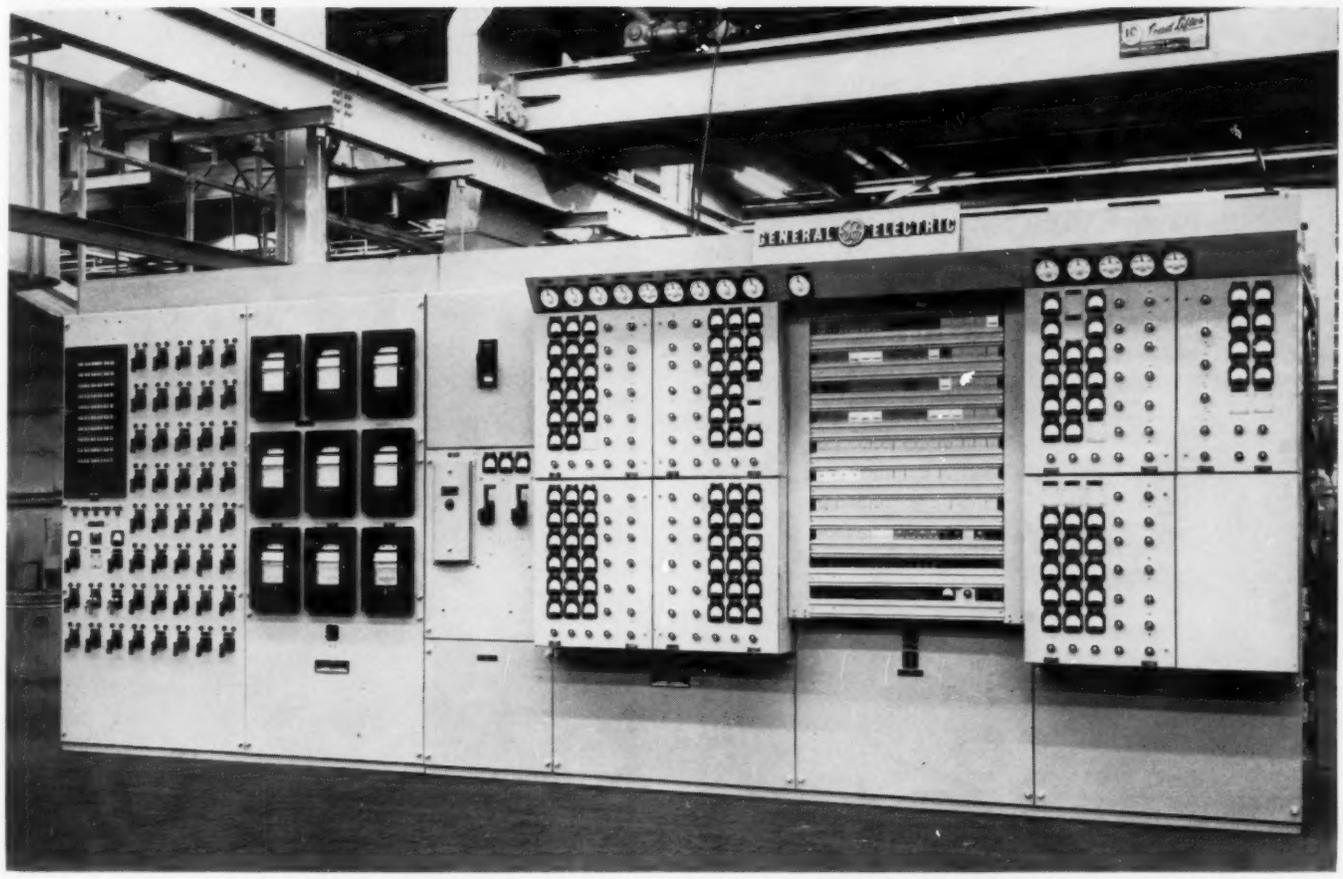


Figure 2 — This panel provides adjustable voltage control for the main drive of a slabbing control. Static switching units were used to replace the relays formerly required for mill reversing.

Would Mr. Erbe please explain whether static or relay type devices were utilized to establish the various reference regulator signals for the skip hoist drive?

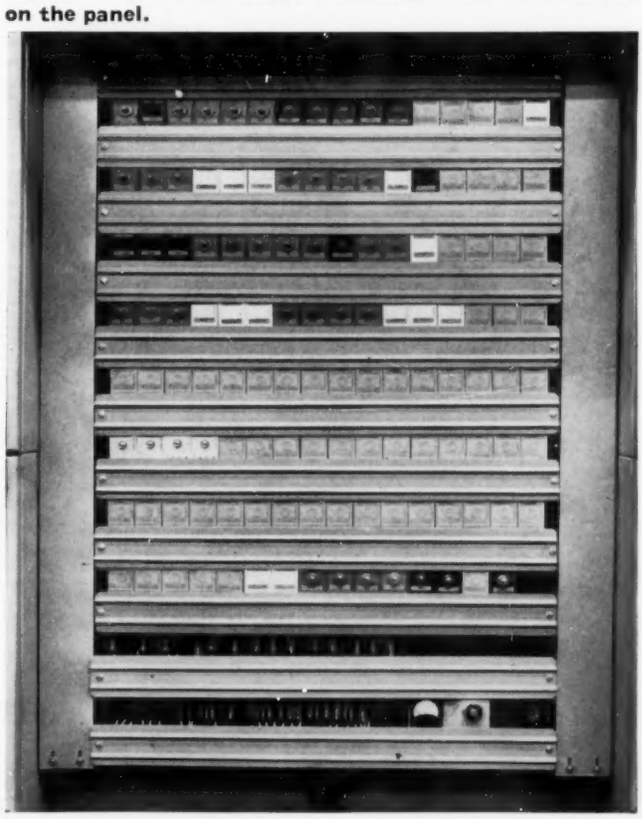
The panel shown in Figure 2 provides adjustable voltage control for the main drive of a slabbing mill. Static switching units were used to replace the relays formerly required for mill reversing. Notice the emphasis placed on the functional design and appearance of the panel layout. Steel bases are used throughout. On the panels are all of the regulating circuit components and instruments, packaged for ease of maintenance and adjustment.

Figure 3 shows a closeup view of the recessed panel, shown above on which are mounted all of the static switching units. This figure also illustrates the ease of identification of the multi-colored units. Almost 50 per cent of the units shown are the grey isolated switch unit. This indicates the number of circuits in a modern adjustable voltage system that require the switching of regulator fields.

Lately, the utilization of circuits involving regulation of the rate of change of generator voltage rather than current limit control for acceleration and deceleration has been found to be very desirable. The rate regulator is particularly well suited for belt and cable drives since the motors can be accelerated at a constant rate thus further reducing the stresses imposed upon the machines. The rate of acceleration is adjustable over a wide range. Thus the drive can either be accelerated and decelerated either quickly or slowly but always at a linear rate of change of speed.

As experience was gained with static switching systems, it became apparent that panel designs could be considerably improved if some of the other devices used in conjunction with the basic static switching units were made electrically and mechanically com-

Figure 3 — This is a closeup of the recessed panel shown in Figure 2. All of the static switching units are mounted on the panel.



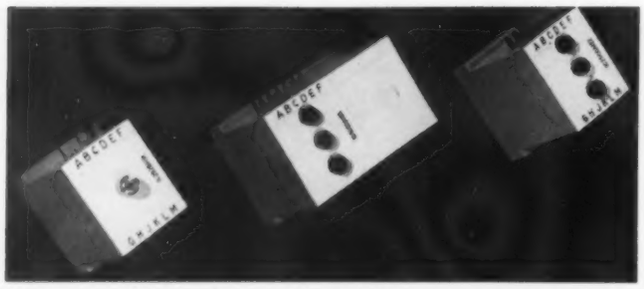


Figure 4 — Shown from left to right, are an encapsulated relay designed to operate from a switching unit, a transistorized a-c amplifier unit for a hot metal detector, and a transistorized d-c amplifier unit for a tensiometer control.

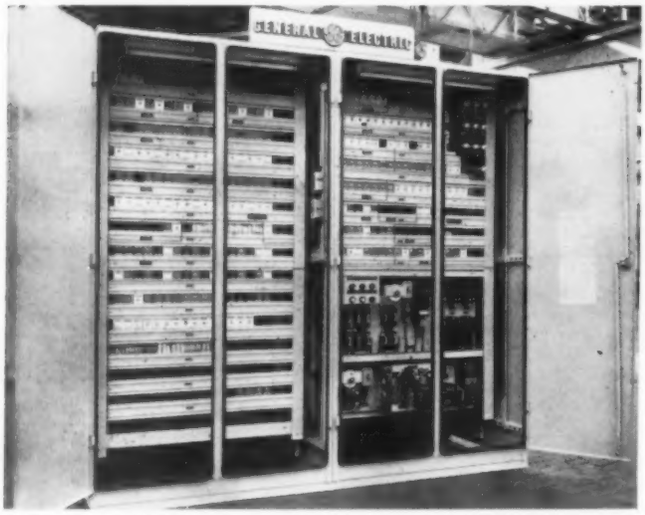


Figure 5 — This equipment is an automatic program control center for the mill setup and rolling operations for a reversing slabbing mill.

patible. Figure 4 shows, from left to right, an encapsulated relay designed to operate from a static switching unit, a transistorized a-c amplifier unit for a hot metal detector, and a transistorized d-c amplifier unit for a tensiometer control. These modules can be plugged into the standard static switching bus strip. Three jack-plugs are included for maintenance testing. Like units are readily interchangeable in case of failure.

The equipment shown in Figure 5 is an automatic program control center for controlling all of the mill setup and rolling operations for a reversing slabbing mill. Input signals are received from a static card reader and are channeled by this static director to the static

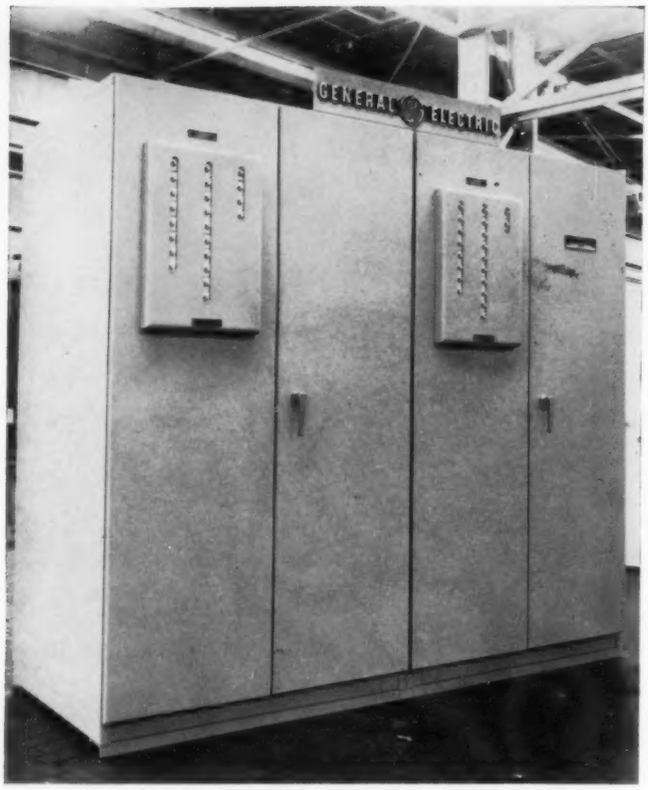


Figure 6 — This is a view of the equipment, shown in Figure 5 when its doors are closed.

main drive control system, shown previously, thus integrating an all inclusive static switching system. The enclosed view of this equipment is shown in Figure 6.

A more extensive program control, over 100 ft long, is currently being completed and will be put into operation on an automatic structural mill later this year. It is designed to accommodate process data from three separate card reader stations.

We share the authors feeling that the time is near when a completely automatic blast furnace charging system will be a reality. The control technology is available now.

J. Raymond Erbe: Relays were used, instead of static type devices, for the skip hoist regulator reference signals because the customer wished to be able to operate the drive manually for maintenance purposes without going through the static control. ▲

There is a constant demand for copies of "The Modern Strip Mill" published by the Association of Iron and Steel Engineers. If your copy is not in use please get in touch with us.

ASSOCIATION OF IRON AND STEEL ENGINEERS, 1010 EMPIRE BLDG., PITTSBURGH 22, PA.

Mannesmann's New Seamless Mill at Sault Ste. Marie

by Robert Hartenstein,
Vice President, Engineering,
and Astor L. Thurman,
Executive Vice President,*
Mannesmann-Meer, Inc.,
Youngstown, Ohio

. . . . this new seamless mill is completely automated to increase its long-time production rate by eliminating the ever-present operated mills . . . . the single groove plug mill provides for quick schedule changing by incorporating in its design means for easily uncoupling its entire main stand and replacing it with a previously prepared stand . . . . complete schedule changing in 30 min is provided for the seven-stand sizing mill by mounting its stands on ways that facilitate easy removal to and delivery from transfer cars which have matched ways . . . .

DURING the past ten years a number of fine new seamless tube mills for the production of line pipe and casing have been put into service in this country. In each case the capital investment has been very high, however, and the production rates, while satisfactory, are still not as good as the rates of some of the older mills. As fine as these new mills are, and as great as has been the contribution of the operating personnel in increasing production rates, no improvements have been made by machinery manufacturers above those brought about by normal evolution.

When one makes a comparison, he soon learns that all major seamless mills built in the last five or six years are essentially the same as the older mills already 25 or 30 years in operation. In spite of the fact that seamless mill equipment has remained essentially the same over this long period, a closer examination of the operating records indicates a rather phenomenal increase in mill production rates. While the seamless mill machinery builders have watched from the sidelines, the operating companies have made tremendous advances in the use of their antiquated machinery, and therein, perhaps, lies the principal reason steel mill customers have been satisfied to purchase such seamless tube mill machinery. Tremendous advances have been made in the last 25 years in pass design, rate of feed, improved rolling techniques, all resulting in increased rolling speeds to provide higher and higher production rates.

In spite of these advances, however, the seamless tube industry must look for still further improvements in quality, improved tolerances and increased production rates. Consider for example the recent advances in electric weld mills on which high quality, close tolerance API casing and tubing are being produced with ease at rates only feasible by the most advanced seamless mill process, the continuous mandrel mill.

It was with this history as background that Mannesmann's new tube mill at Sault Ste. Marie in Ontario, Canada, was conceived. A thorough knowledge of existing mills, their operating rates, the factors which limited their production, and the possibility of improving these various conditions became, in essence, the starting point for the design of this new mill. All goals set for the mill have not yet been achieved although there is every promise that they will be. The final result will not be a revolutionary mill process; but on the other hand, however, neither are the individual mill units conventional and conservative in design as is fairly well known by this time.

To obtain the proper appreciation of the nature of this new project at Sault Ste. Marie it is well to review the basic points which formulated the design background for this new tube mill. The first consideration was the size, speeds and relative location of the machinery necessary to provide the desired production throughout the size range for the intended order pattern, and to have sufficient flexibility to adapt itself to possible future patterns.

Next, consideration was given to the design of each basic machine to eliminate bottlenecks which might curtail production due to the physical operation of the equipment. Third, with all machines designed for a high level of production, their functional operation internally, as well as their inter-relationship with adjacent equipment, was subjected to a study to assure proper material flow.

In this connection the design of the handling equipment became most important to the success of the project as did its close coordination with the major mill components. This was true not only in the hot mill but also in the billet department, the finishing floor and the coupling shop. Next a thorough over-all study was made of the mill layout to assure economical, yet adequate service facilities. The final consideration was the problem of standardization, which involved the use of the maximum number of duplicate components in the auxiliary equipment and where possible in the major machines. This standardization was intended to reduce the engineering hours, the cost of manufacturing the equip-

* Position at time of paper presentation.

ment, the inventory of spare parts, and to improve future maintenance problems in the mill.

One of the first major departures from conventional practice was made early in the planning stages when it was decided that it would be the first seamless tube mill to operate under fully automatic control, a feat which at that time was considered to be in the realm of fantasy. This immediately involved a further study of the detailed operation and inter-relationship of each piece of equipment to assure correct operation and that proper signal devices could be provided for the functions of the automatic control. Partly because of economy and certainly because of its wide adaptability, a modified heat radiation detector unit was selected to perform this function throughout the hot mill. More conventional signal devices suited requirements in other parts of the mill.

This mill, in its conception and long range planning, is as fully automatic as any such operation can be. From receiving the incoming billet to the delivery of the finished pipe, the electrical equipment has been co-ordinated with the mill machinery in such a way that when all equipment is completely installed and on fully automatic operation, it will be possible to start with a cold billet and deliver a finished pipe, threaded, with coupling, tested and oiled, to the receiving skids on the shipping floor, all as a co-ordinated series of completely automatic operations on a single piece of metal. Not all of the equipment is as yet installed to obtain this fully automatic operation, but the mill has been planned and engineered for this degree of automation.

The incoming billet will be automatically cut to a predetermined length by a cutting torch. From that point the billet will be paced through a series of operations, the next of which is the weighing and recording of the billet weight. It will then be delivered to the billet furnace, heated to 2250 F, delivered to the billet centering machine, centered, pierced, elongated, rolled to length, reeled, sized, weighed, measured and cooled. Then, as a cold pipe, it will be straightened, gaged by x-ray, inspected inside and outside, cut off on both ends, threaded on both ends, and delivered to the tester field where a coupling is put on one end. It is then drifted, tested, weighed, measured, stenciled, oiled and delivered to the shipping racks. This was the first seamless tube mill in the world on which such complete automatic operation was ever attempted.

In instituting automation into the conventional seamless tube mill process, it was never thought that automatic operation could in all cases, especially on the small end of the size range, improve upon the possible manual production rate on a short time basis. Rather the intention was to make a gain over an eight-hour period at a steady, high production rate by eliminating the operator fatigue element. With automation in full command the effect of operator fatigue should be eliminated. Combined with the very worthwhile by-product of decrease in operator errors; a substantial gain in pieces per 8-hr turn, even on the smaller sizes, should be made. In handling the larger sizes, of course, the same principles apply, but even greater gains should be expected from the elimination of the fatigue factor.

Unique in this mill also is the concept of an extremely fast schedule change. The design of all mill components have been planned for the possibility of making a complete schedule change from, for example, an extreme of $4\frac{1}{2}$ in. to $10\frac{3}{4}$ in. in less than 1 hr. To realize such a feat, new mill and new table designs, all fully motorized, were developed for the piercing mills, plug mill and reelers; and entirely unconventional designs were necessary for the plug mill proper and the sizing mill.

The new seamless mill layout, Figure 1, includes a settling basin; means for billet cutting, billet weighing and handling; rotary hearth furnace; means for hot billet centering; two piercer mills; a plug mill; two reelers; a sizing mill inlet conveyor; a sizing mill and its outlet table; an automatic weighing and measuring machine; a cooling bed; a rotary straightener with inlet and outlet tables; x-ray inspection equipment for outside and inside inspection; a repair field including gag straightener; two pairs of cut-off machines; three threader fields; low pressure and high pressure test fields; a shipping bay; and a coupling shop.

The new N-80 or high strength casing department is to be located in a third bay, now in its engineering stage. The basic equipment in this department will be two walking beam type furnaces, one for the quench cycle and one for the draw cycle; a quenching unit; a resizing mill; a cooling bed; and handling equipment. A further expansion will include a separate finishing department for this product. At its completion it will be possible to feed the quench furnace directly from the first section of the cooling bed, which would then operate at a higher speed to serve as a chain transfer to feed the pipe directly into the furnace with a shell temperature of around 1000 F. Thus an increase in the production rate of the quench furnace will be realized. Flexibility will be provided to assure that high strength casing can be produced from storage at a lower production rate. In fact, this will be the method of operation used during the initial operating stages of this department.

As a still further expansion of the mill the first step in the production of tubing will be to use one of the walking beam furnaces in the high-strength casing department as a reheat furnace for a new three-roll stretch-reducing mill. This will permit the production of tubing from the same mill with a minimum of additional equipment. Later a continuous mandrel mill will be added for the tubing production to feed the stretch-reducing mill. Alternate plans can, of course, also be considered, but the choice would obviously depend upon the production requirements and the stage of the technological developments at the time the new production equipment is to be added.

The principal individual mill components with some of their features are:

1. *The billet cutting and handling equipment* provides for receiving billets in multiple lengths, automatically selecting and conveying them to their torch cutting position, cutting two billets simultaneously, and delivering the cut billets to the billet transfer system, which can be set to deliver the cut-to-length billets directly to production or to storage. Then the billets are electronically weighed and their weights recorded for the hot mill foreman. They are then delivered to the rotary hearth furnace and positioned for charging.

2. *The 75-ton per hr rotary hearth furnace* has an approximate outside diameter of 80 ft, a hearth designed

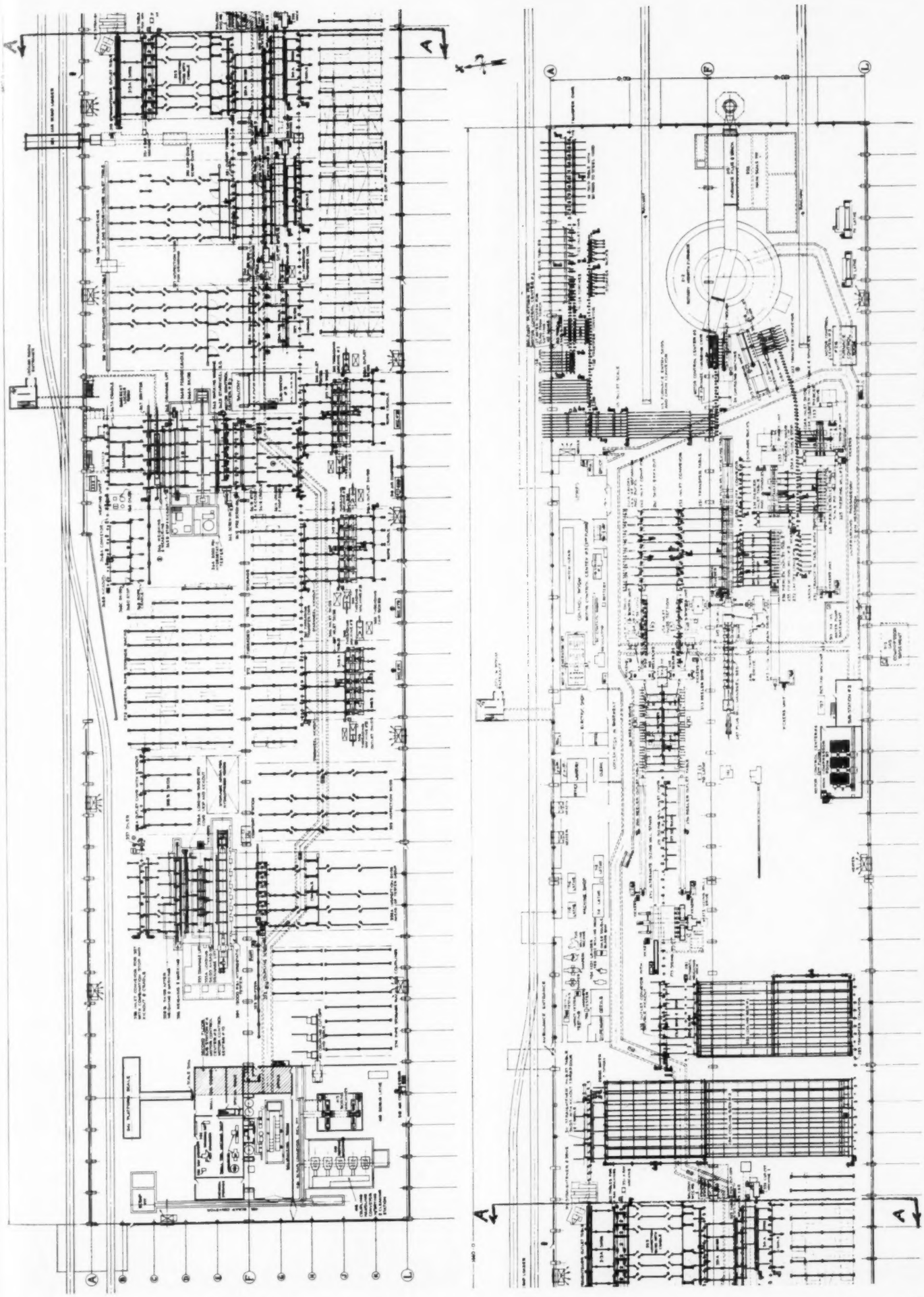


Figure 1 — Layout of new Mannesmann seamless tube mill at Sault Ste. Marie in Ontario, Canada.

for a maximum billet length of 16 ft 0 in., complete automatic combustion control, and fully automatic charging and discharging machines.

3. *The hot billet centering machine* has automatic handling equipment.

4. *Piercing mills No. 1 and No. 2*, each driven by a 4000-hp 600-rpm a-c synchronous motor, have roll surface speeds of 1090 fpm, feed angle adjustment of 5 to 15 degrees, and separate slow turning drives for their main rolls. Figure 2 shows a portion of the billet conveyor from the furnace as well as the drive and inlet side of piercer No. 1. Figure 3 shows the outlet side of piercer No. 1 with a shell at about its mid-point on the outlet table. This outlet table offers several new design improvements, including new roller type mandrel bar steadiers, separate motorized adjustable lower and upper guides for fast schedule change, and a thrust block that is held in its bridge by double wedge type locking during rolling to assure the most stable rolling conditions. Figure 3 also shows one of the detector units which helps to initiate the automatic operation of the outlet table. A radically new drive for the thrust block was also provided. The drive cable is simply reaved over single groove idler and drive pulleys with the cable held in tension by means of a hydraulic pull-back cylinder. This improved design has greatly improved maintenance

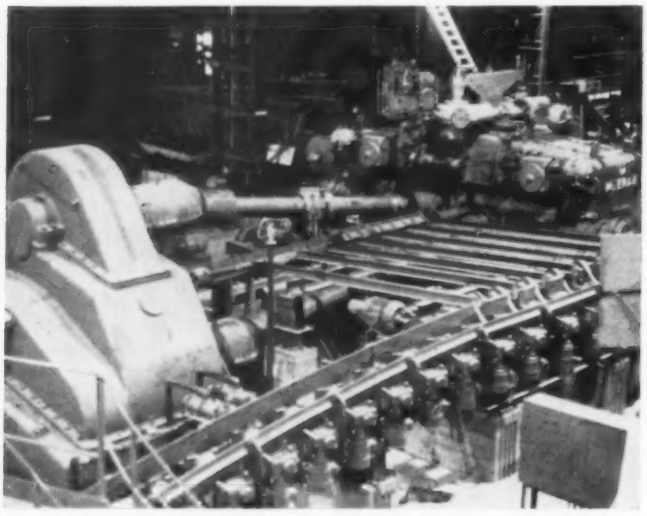
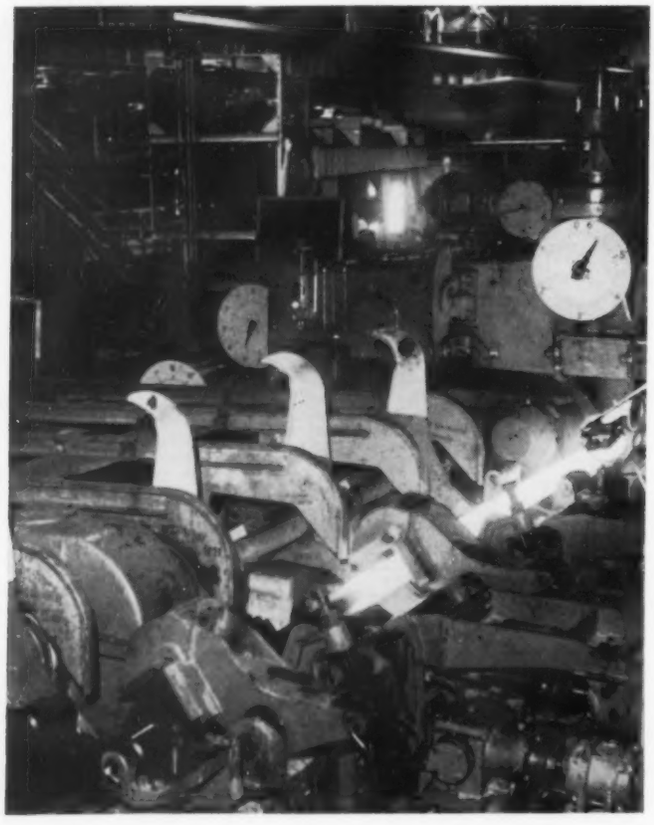


Figure 2 — This is the billet conveyor going to the inlet side of piercer No. 1.

Figure 3 — The outlet table of piercer No. 1 has several new design improvements, one of which is separate motor adjustable lower and upper guides for fast schedule changes.



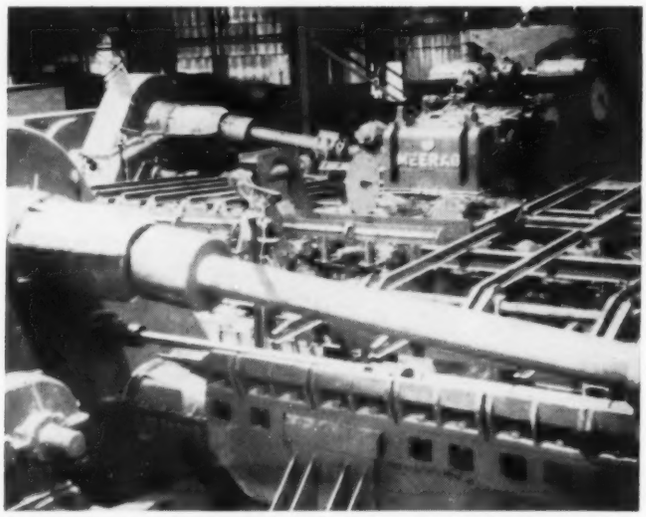


Figure 4 — In the foreground is the inlet table for piercer No. 2 and in the background is the inlet table for piercer No. 1.

Figure 5 — This view is from the inlet side of the plug mill during operation.

conditions on the drive, and it should certainly prolong the cable life.

Figure 4 shows the inlet table for piercer No. 2 with piercer No. 1 in the background.

5. *The single groove plug mill* has each of its main rolls separately driven by a directly connected 2000-hp, 0/125/160-rpm, d-c motor whose power is supplied by a flywheel motor-generator set. The main motors accelerate on each pass; the shell enters the rolls at the maximum practical preset entering speed; and the motors accelerate to a preset speed. An anticipating control is provided to assure that by the time the shell enters the rolls, the main motors have already started to accelerate so that no relay time interval is lost. The design of this mill is such that the complete main mill stand is removed, and a previously prepared spare stand is put in place when there is to be a schedule change or a roll change. The main mill housing is locked to the mill base plate by hydraulic wedge type locking. Quick disconnect couplings are provided to assure fast change of the main mill stand.

Figure 5 shows a view from the inlet side of the plug mill during operation.

Besides the advantages of greatly increased accessibility and fast schedule change, the single roll design offers several other worthwhile features. In the first place, the receiving table and mandrel bed can be made very simple, and both can be anchored solidly to their foundation because there is no need for movement to suit groove alinement.

Both the receiving table and the mandrel bed are designed to facilitate fast schedule changes. The receiving table needs only to be adjusted in elevation for different shell diameters. When going from a small size to a large size, above 7 in., provisions are made for a fast pusher-cylinder change. The mandrel bed is designed with separate upper and lower guides which have motorized adjustment to suit various pipe sizes. This eliminates the need for guide changes. Also, the upper guides are hydraulically opened to permit quick removal of the mandrel bar. The mandrel bar can be hydraulically disengaged and moved to position for quick removal.

The plug mill receiving table is provided with means for motorized 90-degree rotation of the shell between passes by separately driven raise-and-lower rolls. This has proved to be a very worthwhile improvement for all shell diameters and is especially advantageous when rolling larger shells.

By providing acceleration on the main mill rolls, the plug mill is no longer the bottleneck in production because the cycle time for this mill has been substantially reduced. Figure 6 shows a side view of the plug mill with one of the main drive motors in the foreground.

6. *The two reelers* are each driven by two 400-hp, 720-rpm, a-c motors. With a separate drive on each motor the inlet table has been considerably simplified and accessibility greatly increased. Figure 7 shows a closeup of the No. 1 reeler from the outlet side with the No. 2 reeler in the background. Another point of particular importance is the ruggedness of these reelers as is indicated in Figure 7. These reelers provide for better conditions than any built to date for this size of pipe. Figure 8 shows an over-all view of the two reelers with the billet cutting and handling equipment in the far background. The roll diameter alone does not, by any means, tell the whole story because these reelers have been made heavier than usual for their 32-in. diam rolls. They have very rugged construction for every component together with hydraulic wedge type locking of the upper and lower guide shoes, the inlet cannon, and the top guide chair. This combined with sturdy hydraulic

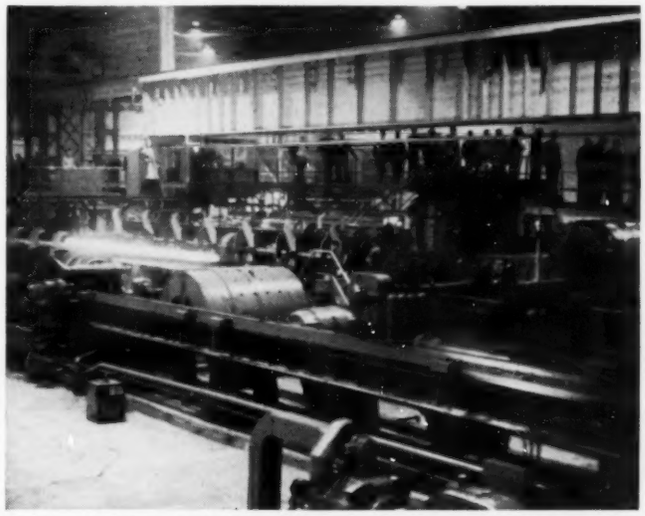


Figure 6 — In the foreground of this side view of the plug mill is one of the main drive motors.

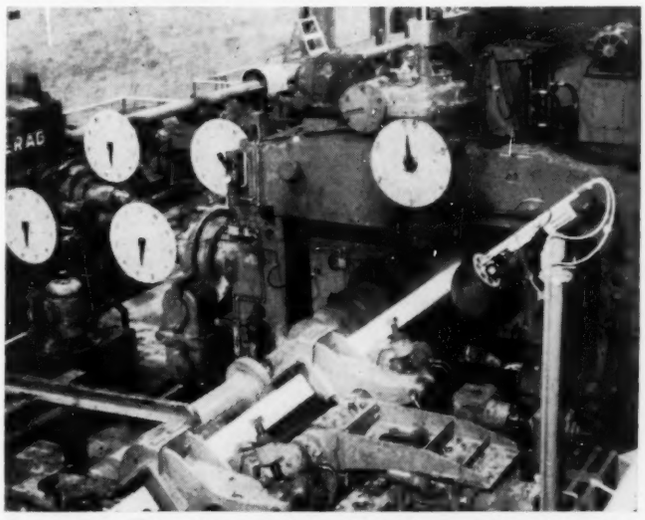
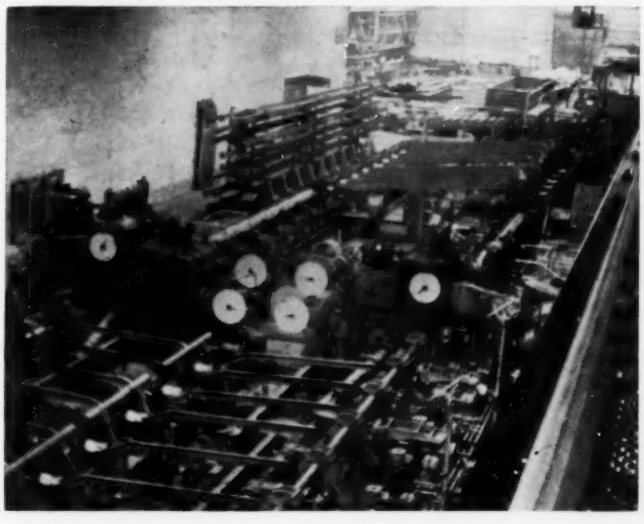


Figure 7 — This closeup shows the No. 1 reeler, from the outlet side, with the No. 2 reeler in the background.

Figure 8 — This over-all view of the two reelers shows the billet cutting and handling equipment in the background.



roll-chuck pull-back makes possible a rolling effect not yet accomplished on any other reelers. To assure high speed production the rolls are geared to run at a speed corresponding to about 1420 fmp, and the thrust block drive provides for speeds up to 1200 fpm.

7. *The 7-stand sizing mill*, driven by a 600-hp, 720-rpm main motor is geared to provide a pipe speed of approximately 250 fpm. This mill, as shown in Figure 9 is another one of the units which offers several innovations over previous sizing mills. The basic difference is the provision for fast schedule change by removal of any one, any group, or all of the mill stands to an adjacent transfer car mounted on rails parallel to the mill. This change is made simply by disengaging the hydraulic stand clamping and the quick disconnect water and grease connections, attaching the stand removal device to the stands to be removed, and pulling the stands on their ways out onto corresponding ways on the transfer car. This car is then moved along the tracks, and a second transfer car with the previously prepared replacing stands is brought into position before the mill and the above procedure reversed to put the new stands in place. By use of this design it is possible to change a complete rolling schedule on this mill in less than 30 min.

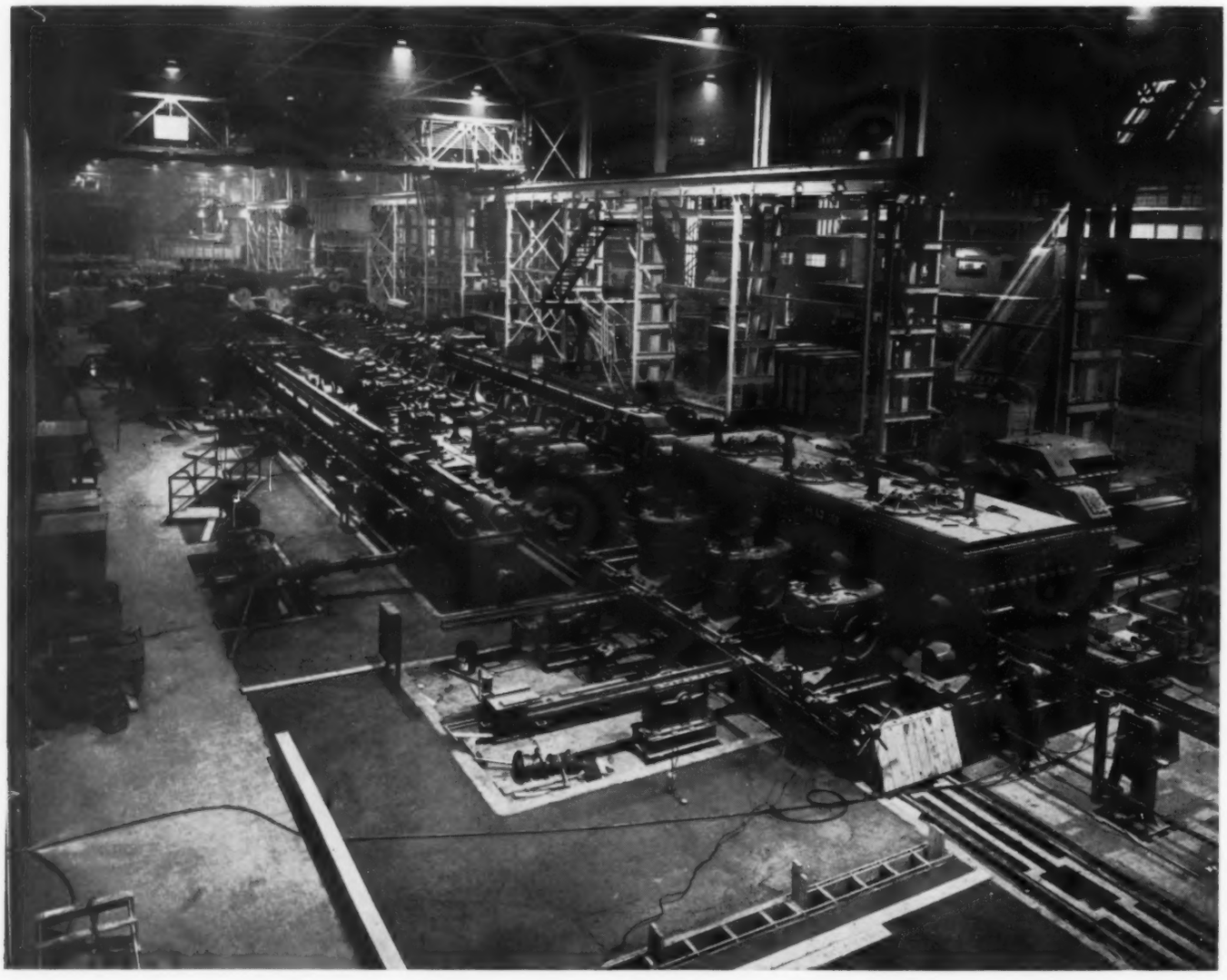
Figure 9 shows a view of the mill during construction with four stands in the mill and with the two-stand changing truck supporting eight additional stands. Although this mill was the latest design available at the time of its delivery, a 7-stand mill of a similar but improved design has since been delivered. A still newer design of 2-roll resizing mill has been designed on the same principal for use on the N-80 program now being engineered for Sault Ste. Marie.

Because of the improved performance of the 3-roll mill so widely applied in the last few years to stretch reducing and conventional reducing mills, this principle has recently been used in the design of sizing mills ranging from the API tubing size range of $2\frac{3}{8}$ in. and $2\frac{7}{8}$ in. outside diam up to API casing or line pipe sizes of $10\frac{3}{4}$ in. Thus the advantages made available in the 3-roll design for straight reducing and stretch reducing mills have now been extended to sizing mills, the principal advantages over the 2-roll being simplicity of design and greatly improved surface quality of the outgoing product.

8. *The two-section cooling bed* provides pipe travel of 230 ft. It includes an electronic pipe weighing and measuring unit located at the start of the cooling bed. The purpose of this electronic scale is two-fold:

a. Through the proper devices, the weight per foot

Figure 9 — Schedule changing for this seven-stand sizing mill is provided for by easy removal of any one, any group or all mill stands and replacement by previously prepared stands. Only 30 min are required to change a complete rolling schedule.



of the pipe in process can be relayed to the roller on the plug mill, giving him continuously an indication of conditions on the mill.

b. It gives a weight which is compared with the billet weight determined by the electronic scale ahead of the furnace to calculate the scale loss.

The product is weighed by using load cells and is measured in length mechanically. These two signals are electronically registered on a computer which supplies a weight per foot signal to a dial at the receiving table operator's pulpit. This dial has three needles, two of which are manually preset for the upper and lower points of the wall tolerance; the third pointer is actuated by the computer. The plug mill roll screwdown can be adjusted by the receiving table operator in accordance with the trend of the dial readings.

Figure 10 shows a view of the cooling bed taken from one of the cutoff machine tables with one of the cutoff machines in the foreground.

After the pipe has been cooled, it is put through the following different equipment components:

a. A rotary straightener is provided with custom designed inlet and outlet tables which were specifically arranged as the connecting point between the automation requirements of the hot mill and finishing department.

b. The straightener outlet table is followed by transport skids which advance the pipe to the primary station of the x-ray automation system. This equipment consists of two oppositely mounted industrial x-ray machines which sequentially probe-inspect first one end and then the other of each pipe as it progresses automatically through the equipment. The x-ray unit determines the length of crop end to assure that the wall thickness of the remaining product is within the allowable tolerance with the limit point being indicated by a paint spray marking on the surface of the pipe. The intermediate transportation between the two x-ray probe units is provided by a unique system of walking beams with the speed of production being automatically regulated to suit the size of pipe in production. Beyond the x-ray unit the pipe is interrupted in sequence for visual inspection, both internal and external. It then continues under full automation through the remaining operations in the finishing department.

Figure 10 — In the foreground of the cooling bed is a cutoff machine.

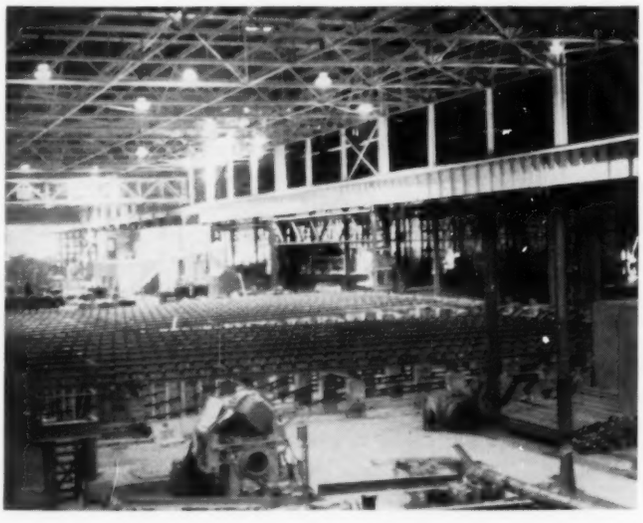


Figure 11 — In the background of this view of the finishing floors are storage racks and threading equipment.

c. Next come two sets of cutoff machines with special new design tables similar to the ones provided for the x-ray units.

d. Last come two sets of threading machines with tables operating in full automation. A third set of threading machines is yet to be installed.

Figure 11 shows a view of the finishing floor in the foreground. In the background are some of the storage racks and the threading equipment.

e. Automatic handling equipment for the finishing floor operations provide for the proper sequencing of related operations. The use of specially designed conveyors, walking beam type tables, stops and kickout devices control the position of each pipe in such a manner that it arrives in its proper entry position at the machine designated for the next operation. Should a tool change or minor maintenance delay cause the inlet table of a particular machine to become filled, the pipe will be automatically diverted to the inlet table of an alternate machine. At the end of delay the original feed sequence is automatically resumed.

The sequencing described above is common in numerous applications where accommodations must be made in the sequencing until rectification of the delay. This is true in the hot mill as well as in the finishing department.

f. One 13,000-psi hydraulic tester field provides for final inspection ahead of tester, stenciling of brand, pipe diameter and wall, coupling pre-screw-on, coupling screw-on and drifting ahead of tester. Following the tester is a drainage lift; an automatic weighing, measuring, and stenciling machine; and the delivery conveyor to the pipe coating machine.

Figure 12 shows the outlet side of the tester, the middle

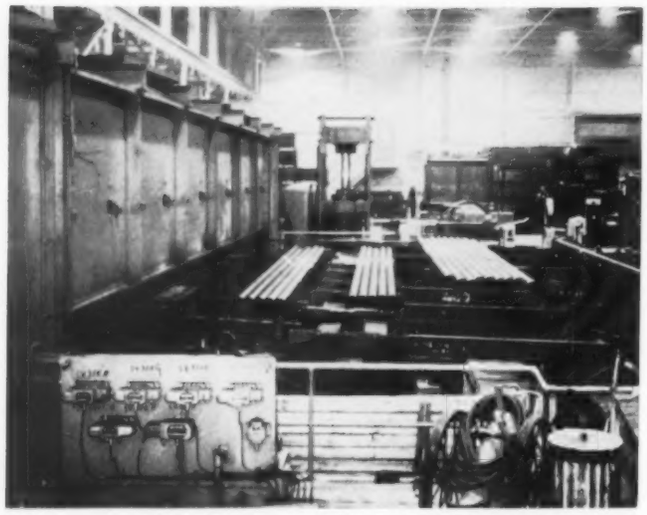


Figure 12 — This is the outlet side of the tester. The center group of tubes is located on the drainage lift, which is shown in the down position.

group of tubes being located on the drainage lift, which is shown in the down position.

g. One pipe coating unit with outlet table provides for controlled spray type coating of the pipe and its transfer to the drying racks.

A second tester rated at 3000 psi is already on order, and engineering is being done for the addition of this 3000-psi test field. Besides the above normal production facilities for pipe and casing this mill also has a modern coupling shop which is complete with coupling cutoff, automatic coupling boring and tapping, coupling transfer, cleaning, pre-inspection, plating equipment, and final inspection equipment.

Figure 13 — Shown here in the coupling shop are vertical tapping machines. Completed couplings are being fed into the spray type washing machine.

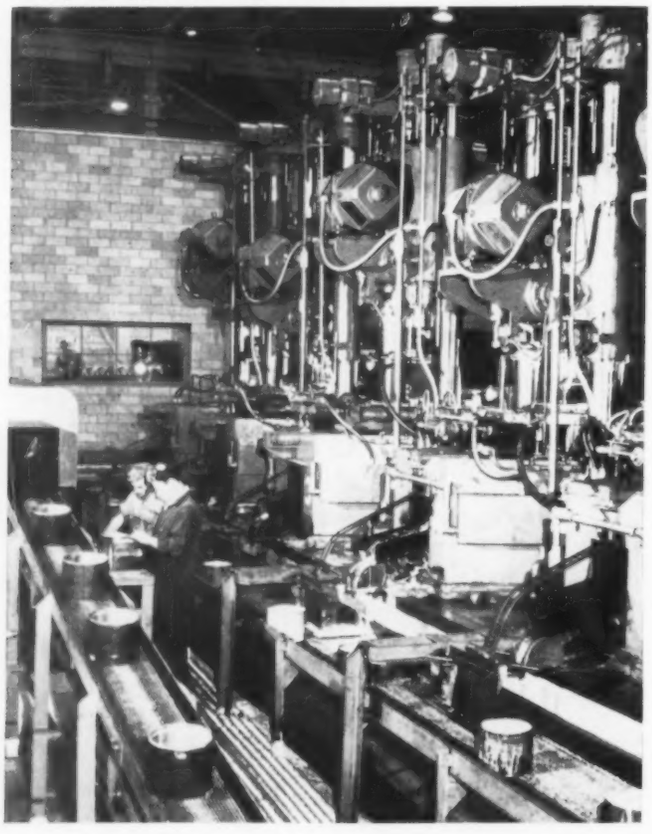


Figure 13 shows a view of the vertical tapping machines in the coupling shop and completed couplings being fed into the spray type washing machine.

There are also complete machine shop facilities to assure quality control of all products.

Some of the interesting features of the over-all mill construction and service facilities are:

1. The mill building itself is of relatively low cost yet of very sturdy construction. The main mill is placed in two 100-ft bays, 1440 ft-0 in. long. The first stage of the high strength casing department will be housed in a third, 100-ft bay, 840 ft-0 in. long, which has already been constructed. Columns are on 20-ft spacing at all points except where there is to be a cross transfer the spacing is generally 60 ft-0 in. One exception is in the hot mill where a better mill layout was possible by using one 80-ft-0 in. span. Side walls are glass insulated, sandwich galvanized asbestos construction, and there are no windows in the outside walls. The roof is relatively flat and is made up of precast concrete slabs, supported in fabricated steel framework.

2. The cranes are of sturdy yet low cost construction.

3. The mill scale handling system collects the scale in a water pit under each hot mill unit and pumps scale and water to a central settling basin. After the scale has been settled out of it, the water is recirculated; and the the scale is removed from the settling basin by a clam shell.

4. The piping and electrical service tunnels and basement system made it possible to install piping, wiring and cable with a minimum of imbedded pipe and conduit. Piping and wiring is installed in racks along the sides of the underground tunnels. This assured ease of installation and ready accessibility for maintenance. Because of the plant location practically all of the tunnels and basements are below water level. Soil studies made prior to the start of engineering made it evident that all engineering and planning had to be based on this condition.

5. Automatic motorized scrap handling systems are provided for both the finishing floor and the coupling shop. A motorized underground conveying system is provided for the cutoff machines. This conveying system ultimately delivers the cutoff pipe ends to a scrap car outside of the building. The coupling shop has a conveyor system which delivers the turnings and chips to a scrap pit from which this material is removed by crane to scrap cars.

6. General plant services:
   a. Coke oven gas is purchased from the Algoma Steel Corp., with provisions for stand-by oil firing.
   b. Heating is by unit heaters which are coke-oven gas or oil-fired.
   c. Mill ventilation is provided by roof fans in summer, and motor rooms are air conditioned.
   d. Water is purchased from the Algoma Steel Corp. For this reason the water system was laid out to provide a maximum of recirculation. All water discharged from the mill service supply is treated for removal of oil and contamination before being discharged. A separate high-pressure water system is pro-

vided for mandrel bar cooling.

e. Sewer systems, practically all below water level, must be handled in a way that assures continuous flow. This means that practically all sewage must be discharged through pumps or through long runs to lower elevations.

f. The compressed air system, fed from a central location with main and stand-by units, has supplementary compressor units in the cutoff and threader areas and the coupling shop. Under emergency conditions these areas can be operated with main mill air pressure at lower production rates.

g. All unit mill conveyors, transfers, etc., throughout the hot mill, finishing floor and coupling shop, are automatically lubricated where practical, and generally by individual motorized systems for each unit. Individual oil lubricating systems are provided for all major drives; all are protected by electrical alarms.

h. Individual hydraulic pressure systems for each major unit are provided to make pressure available to all hydraulic cylinders, and all are interlocked to prevent damage in case of loss of pressure.

j. The plant electrical power system is fed from the Great Lakes power system at 110 kv. The main outdoor substation is rated at 15,000 kva, 110/4.16 kv, 3-phase, 60-cycle with provisions for future addition of forced air cooling to raise the rating to 20,000 kva. The total connected horsepower in the mill is over 22,000 hp. Two 500-kw, 250-v sealed ignition rectifiers provide d-c power, and four 1000-kva, 4160/480-v unit substations provide miscellaneous a-c power to feed ten motor control centers, all of which have drawout panels.

k. Because the coordination and general engineering of the entire facility was under the direction of one company, it was possible to standardize on the design of many of the components used throughout the mill. For example, it was a natural step in the development of the mill design to use standardized individual motorized roller conveyor units throughout the mill. Other components that followed the same pattern were the kickouts, stops, walking beams, and other similar devices. Even standardized base structures were used in all designs, an example being the basic bed structure of the x-ray table. This was true in the billet cutting department, in the hot mill, and throughout the finishing department. This standardization of components reduced the capital investment for the complete project by making savings in engineering time and especially in manufacturing costs, and by minimizing the costs of replacement parts. Another obvious advantage is in long range reduced maintenance costs.

The mill was engineered, manufactured, installed and put into operation in a period of about 18 months from the time the order was placed at a cost of under $20,000,000, which includes operating supplies and spare parts. Inauguration day was June 15, 1957, at which time the mill was in operation on automatic control but with untrained crews. It is felt that possibly the automation of this mill helped these men get through that day without a cobble.

While it is still too early to publish production figures, it is not too early to take an optimistic attitude from some of the operating results which have been obtained thus far. From what has been seen it is felt that the Mannesmann Tube Co. will be able to produce line pipe and casing at a rate and of a quality attainable by few, if any, of the existing seamless tube mills.

Discussion

PRESENTED BY

PAUL SAVAGE, Assistant Vice President—Operations, E. B. Germany Works, Lone Star Steel Co., Dallas, Texas

ROBERT HARTENSTEIN, Vice President—Engineering, Mannesmann-Meer, Inc., Youngstown, Ohio

DR. R. M. REICHL, R. M. Reichl Co., Forest Hills, N. Y.

E. A. GILMORE, General Superintendent, Mannesmann Tube Co. Ltd., Sault Ste. Marie, Ontario, Canada

S. O. Evans, Manager of Tubing Operations, Tubular Products Div., The Babcock & Wilcox Co., Beaver Falls, Pa.

Paul Savage: I would like to inquire about the success of the automatic weighing device.

Robert Hartenstein: I wish we could say it had been completely setup. Unfortunately, it has not. It is intended as a weighing device ahead of the cooling bed and will function two-fold. We have every reason to expect that it will be successful. It is a matter of programming rather than a matter of degree of failure of the equipment. The intent is to send a signal back to the plug mill roller's position so that the plug mill roller can, in turn, anticipate the necessary roll setting and make it from his operating position. This would be a computer operation using the length signal and combining it with the weight signal to calculate the weight per foot.

The x-ray has been extremely successful. The x-ray is a conventional piece of apparatus. We have only provided the mechanism to make it automatic. The unit functions on the basis of a six-foot length probe. The indication signal, of course, is a paint spray. As the paint spray goes on or off, we get the indication of whether we are on-gage or off-gage and the point on which we go on-gage or off-gage.

Paul Savage: Does it just show gage?

Robert Hartenstein: That is all it does.

Dr. R. M. Reichl: I notice that your installation comprises a pipe testing machine which goes up to 13,000-psi test pressure. Have you included plans to produce also higher grades such as N-80 or P-110? Nobody knows how high we may have to go in the future.

Robert Hartenstein: We have the building available now. The equipment is on order for N-80. That program will be the next program instituted in the mill.

Dr. R. M. Reichl: Do you buy the billets on the outside?

Robert Hartenstein: Yes, we buy them from Algoma Steel Corp.

Dr. R. M. Reichl: Are the billets ready for the piercer mill as they are being delivered to you?

Robert Hartenstein: Yes, to a degree. Billet conditioning is always a problem. With a mill that has had considerable experience in producing rounds that problem is something they have lived with all their life. Algoma is producing rounds for piercing and experiencing new problems with them. We have had varying degrees of success. However, I think the mill's quality of product has reflected the fact that they have learned as well as we have.

E. A. Gilmore: The subject mill has been operating since June 1957. Production progressively increased, especially in February 1957, as most of the "bugs" have been overcome in our operating practices and mill equipment. It has assured us that we are going to meet the expected production rates that were designed into the mill. The aspect which I was much concerned about when starting this mill was its automation. Being an old timer I thought that was where I would have my trouble; but the automation is entirely successful, and we have very little trouble with it.

S. O. Evans: I am very interested in the ingenuity involved in reducing change-over time. Mr. Thurman said the change-over time for the sizing mill is under half an hour. I do not remember if he mentioned the time on the plug mill; I am interested in that.

Finally, I am interested in the 13,000-psi test bench. I assume that the testing there is done after threading.

Robert Hartenstein: Yes, the testing is done after threading.

S. O. Evans: I am interested in the nature of the shrouding involved for the protection of the inspectors.

Robert Hartenstein: The first point was the time requirement on the plug mill itself. You indicated we mentioned a one-hour change time from minimum to maximum size on the mill. Specifically, the plug mill, being a single groove mill, follows a different pattern than the conventional plug mill as we see it. Actually, we changed the entire mill stand as a unit; therefore, we have a completely new setup on the floor for the new size. The change time probably involves more ingenuity in the method of hooking up the various devices. Other than that, it is purely a matter of bringing back the hydraulic lock wedges holding the stand in position, and substituting one stand for another. I think we probably spent as much time hooking up the pipes from various sources, and we are constantly simplifying this problem. Throughout the entire hot mill area, however, those problems of time change have been given as much consideration as any other design factors.

Your second point on the tester concerned shrouding. Shrouding is pretty much conventional for most manufacturers. It is a standard door-type opening and side discharge tester. From our experience, we have had very good results with the shrouding effect. In construction it is purely a box with side opening doors. ▲

Available Translations

As a service to readers of the *Iron and Steel Engineer*, a list of translations from foreign articles is being printed intermittently. Articles selected for this listing will be those thought to be of primary interest to the American steel plant operator. The papers may be obtained from the Cooperative Translation Service, The Iron and Steel Institute, 4 Grosvenor Gardens, London, S. W. 1, England. All correspondence concerning price, ordering and so forth should be directed to the preceding source.

1086 HARJES, W.: "Resistance to Thermal Shock of Various Basic Refractories," *Radex Rundschau*, 1957 (2), pp. 501–507.

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1091 ANON.: "Complex Automatic Control in the Iron and Steel Industry," *Stal'*, 1958, June, pp. 481–485.

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1145 LECLERC, L., and J. GOREAU: "Determination of Nozzle Sizes and Rates Adopted for the Teeming of Drawing Rimming Steel Flat Ingots," *Rev. Met.*, August, 1958, pp. 710–715.

1078 SCHUERMANS, R., and J. VAN NESTE: "Raw (Unfired) Converter Bottoms at the Seraing Basic Bessemer Steelworks, Cockerill-Ougree," *Rev. Univ. Min.*, August, 1958, pp. 270–279.

1104 UHLITZSCH, H., and G. RADOMSKI: "Use, Manufacture, and Heat Treatment of Alloy Cast Steel Rolls, I—Stresses which arise in the Heat Treatment of Cast Steel Rolls, and their Calculation. II—Materials, Applications, and Casting of Cast Steel Rolls and Various Forms of Heat Treatment," *Neue Hutte*, I, November, 1957, pp. 655–664; II, January, 1958, pp. 10–20.

1130 KAUFMAN, M. M.: "The Use of Water-Cooled Plugs in the Piercing of Billets," *Stal'*, February, 1958, pp. 144–151.

by Gilbert D. Dill, Process Engineer, Steel Div., Wheelabrator Corp., Mishawaka, Ind.

Mechanical Blast-Cleaning of Carbon and Alloy Steel Strip

. . . . cost reduction and recovery of the iron content of scale can be realized by using mechanical blast-cleaning instead of pickling . . . . modern blast-cleaning equipment and abrasives have been improved until former objections, poor product surface and excessive equipment downtime, have been eliminated . . . .

THE steel producers and companies processing steel are today stressing manufacturing economies by improving product quality, lowering production costs, conserving raw materials and reducing industrial wastes.

Mechanical blast cleaning is one of many processes producing these economies and has as one of its most important potentials the recovery of iron oxide for its metallic iron content. Last year 75,188,045 tons of low carbon steel, sheet and strip, were descaled by acid pickling.

This total is reported in *Steel's 1958 Metal Working Year Book* and represents material shipped by the steel mills in the following classifications:

1.	Cold rolled sheets	71,437,810 tons
2.	Galvanized sheets	2,375,420 tons
3.	All other coated sheets	195,240 tons
4.	Cold rolled strip	1,179,575 tons

All of these products started as hot rolled material covered with iron oxide amounting to approximately 1 per cent of the total tonnage. Based on the above tonnages and disregarding metal scrap losses, there were 751,880 tons of iron oxide removed in the pickle lines. Assuming that one-half of this was removed and recovered at the scalebreaker, the loss was 375,940 tons down the drain as iron sulphate.

The blast cleaning process would have removed and recovered this material; it could have been converted to approximately 263,158 tons of iron by way of the sinter plant or briquetting and charging into open hearths or electric furnaces. Recovery of this tonnage would be most important to our national economy and, on a smaller scale, to all manufacturers and processors of steel.

Can mechanical blast cleaning reduce production costs? This question is the first raised by those seriously considering this process. The answer is yes as illustrated by the following:

An Ohio steel producer has an over-all cleaning cost of $2.80 per ton for his combination blast cleaning and flash pickle line producing steel for cold rolling. Comparing this to an over-all cost of $3.25 for 100 per cent acid pickling results in a saving of $0.45 per ton.

A large producer of deep-drawn electrical products has an over-all cleaning cost of $3.00 per ton for his 100 per cent blast cleaning line. Comparing this to their former practice of purchasing hot rolled pickled and oiled stock at a cost of $8.00 per ton above the base price results in a saving of $5.00 per ton.

Ten years ago mechanical blast cleaning was generally considered too costly when high maintenance and downtime resulting in production losses were considered. It was further condemned because of the adverse effects on the finished product produced by the cast iron grit, the only abrasive available for use in the process at that time.

Operating blast cleaning installations numbering well over 100 prove this once universal opinion can no longer be considered a true analysis of the process. The modern version, resulting from constant improvements in equipment and abrasives through extensive research, presents an entirely different picture. The process consists of applying a high velocity blast to the entire surface of the strip from multiple centrifugal wheel units rotating at high speed. Properly controlled and directed the millions of abrasive particles will pulverize and remove the scale. This basically is the process; however, its detailed application is considerably more complex and involves such factors as:

1. The equipment must efficiently clean the speci-

fied material at maximum rates dictated by production requirements.
2. Equipment must be designed to operate 20 turns per week consistently.
3. An abrasive which does not contaminate the surface of the material being cleaned and retains its shape and size throughout an extended useful life thereby reducing consumption must be used.

Current equipment is ruggedly built and entirely lined with abrasive resistant alloy. Its major component is a highly efficient abrasive propelling wheel. It is supplied in capacities ranging from 10 to 100 hp depending upon the application requirements. It is constructed of wear-resistant alloy where needed and is enclosed in an alloy lined housing designed for easy access and quick, easy replacement of component parts. As an example, the throwing blades of the wheel, whose average life is about 1500 hr using steel shot, can easily be replaced in approximately 10 min. All other component parts are similarly designed for quick, easy maintenance.

Equipment design is an important factor in the application and operation of this process, but the greatest single operating cost factor is abrasive. The following estimated figures for one 40-hp wheel unit show the unit costs for one hr of continuous blast cleaning operation:

1.	Abrasive—8 lb per wheel per hr @ $0.13 per lb	= $1.04
2.	Replacement of spare parts per wheel per hr	= 0.20
3.	Maintenance labor	= 0.20
4.	Power @$0.01 per kwhr	= 0.40
	Total cost per wheel per blasting hour	= $1.84

This total multiplied by the number of wheel units on a given machine comprises the total operating cost per hour. Machines equipped with lower or higher horsepower wheels will have correspondingly lower or higher costs.

Our company is producing premium quality abrasive to meet the requirements of surface finish, high production, and low cost. In the round ball or shot type abrasives, our steel shot is performing with exceptional efficiency. Our angular or grit abrasive is equally popular for those applications where shot does not give the desired results. These premium abrasives are furnished in all of the SAE sizes and have the following hardness characteristics:

1.	Cast steel shot.....	42 to 50 Rockwell C
2.	GP angular or grit abrasive.....	44 to 54 Rockwell C
3.	GL angular or grit abrasive.....	52 to 62 Rockwell C
4.	GH angular or grit abrasive.....	60 to 66 Rockwell C

All of these are high carbon, high manganese material, fully heat-treated for exceptionally good cleaning characteristics and long life. For example, a 40-hp wheel unit delivering about 1000 lb per min will only consume seven to eight lb of this shot per hr.

Today, with high quality abrasive and modern equipment, it is possible in most cases to descale hot rolled steel products at a cost per ton under that for straight acid pickling. Steel producers are saving dollars by reducing their acid pickling and acid waste disposal, and steel processors are reducing costs by blast cleaning their hot rolled tonnages at a much lower cost per ton compared to pickled and oiled extras.

Mechanical blast cleaning of steel strip is divided into three major applications as follows:

1. Cleaning of hot rolled stock for cold reduction.
2. Cleaning of hot rolled stock used to produce cold drawn, cold formed, or otherwise fabricated products from hot mill gages.
3. Blast etching of material to provide special finishes for appearance, bonding of coatings such as galvanizing, plating, painting, and other special processes requiring surface etching.

The first application is exemplified by many operations on carbon, silicon, and alloy steels in which the blast cleaner is followed by a very short acid pickle required to remove the extremely thin layer of the base metal not entirely removed by the blast.

In the case of carbon steel, the 14 to 15-sec acid pickle produces a cold rolled product having no more and generally less rolling smut than is now produced from straight pickled stock.

Stainless grades of alloy steel require a short pickle in nitric plus hydrofluoric acid to pacify the surface for corrosion resistance and surface finish properties.

An excellent example of a high-speed carbon steel strip cleaning line is an installation in a newly modernized mill in Mansfield, Ohio. It is a conventional pickle line except for the cleaning section. Here is incorporated a large mechanical blast cleaning unit followed by one 60-ft acid tank. This is a 75 per cent reduction in acid compared to straight pickling and a similar reduction in acid disposal. The line cleans strip 24 to 42 in. wide x 0.09 to 0.205-in. gage at speeds from 200 to 300 fpm, and at a total over-all cost of about $2.80 per ton. It has been stated that the product from their cold mill is the cleanest produced anywhere in the industry. They produce cold rolled sheet products, and the cleaning line has been in operation for about three years. As a result of its performance and tests conducted in this line for another customer, we are at present building a new machine for installation in a rebuilt pickle line. It will clean strip for conversion into tinplate and sheet products and should be in operation the latter part of this year. Total cost per ton from this new line is expected to be even lower.

In the alloy field, there are over 20 installations. These may be in a line with an annealing furnace and acid pacification or in a line without the furnace.

In the first case the process is applied to clean the required sizes of strip at speeds dictated by the annealing furnace, and in the second at speeds dictated by the cleaning facilities of the line.

A good example of a cleaning line without annealing is one of five operations in a plant in the Pittsburgh district. It cleans all grades of chrome and chrome-nickle alloy at speeds from 25 to 75 fpm. Another installation in the Canton, Ohio, district, operating after annealing, is cleaning all grades of alloy at 20 to 40 fpm.

The second application is the cleaning of stock for

production of various items such as automobile frames, wheels and rims, and hardware. Electric weld tubes, conduit outlet boxes, and extruded steel cartridge cases are some of the other end products all made from blast-cleaned steel without any pickling. The prime requisite of this type of application is complete removal of scale, using an abrasive which leaves a blast-etched surface compatible with subsequent processing operations. Another important requisite is proper lubrication of the blasted surface. Comparing it to a pickled surface, it has been found that its etch extends from the normal surface outward while that of pickled stock extends inward due to the acid reaction on the base metal. Actually, most blasted stock gages are thicker after removal of scale, and their surfaces are composed of millions of cupped craters having high and low points which must be well lubricated. It has been shown that this type surface will hold more lubricant per unit of area than a pickled surface. In addition, it has also been indicated that lubricants which work very well on pickled surfaces generally require modification for blasted surfaces. This change is generally toward a higher viscosity and better coating quality to thoroughly lubricate the high points of the etched surface.

A number of our customers experienced high die wear using pickle-surface lubricants on blasted material in their initial operations. A change to a more viscous and better coating compound eliminated their die wear and in some cases have increased their die life beyond that previously achieved with pickled stock. As stated above, the prime requisite in this type of application is complete removal of scale with a resulting etch that is compatible with subsequent processing operations. Of prime importance is the fact that scale not removed will cause die wear in spite of good lubrication.

Mechanical blast cleaning will achieve complete scale removal provided conditions governing correct application are followed and the material is exposed to the blast for a sufficient length of time as dictated by the existing scale characteristics. The rate at which scale can be removed by this process is affected by the following factors:

1. Type and analysis of steel.
2. Hot rolling practice—direct from the ingot, from reheated, conditioned slabs, etc.
3. Type of hot mill—tandem or reversing.
4. Finishing temperature.
5. Runout table facilities for cooling.
6. Coiling temperature.
7. Type of coiler.

These will vary from mill to mill and from order to order depending on the steel producers' methods of producing the right steel for the processors' end product. This means a variation in cleaning rates when steel of the same analysis is purchased from different suppliers. By regulation of the cleaning line speed all of our installations are able to produce good, clean strip and sheets. Products produced from this material are galvanized, electrolytically plated, vitro-enameled, and otherwise coated without acid pickling. Only complete scale removal makes this possible.

There are several installations performing this degree of cleaning on continuous strip and on cut-to-length stock or sheets. One outstanding example is operating in the Pittsburgh district cleaning 36 to 48 in. wide x 0.060 to 0.187-in. gage hot rolled band at 30 to 40 fpm. It is composed of a spindle type pay-off, roller leveler, portable manual spot welding station for coil end splicing, a four-wheel blast cleaner, lubrication applicator, weld cut-out shear, pinch rolls, and spindle type recoiler. Its production averages 50 tons of cleaned stock per eight hour day. They coat in line with a phosphate base drawing compound. The cleaned and lubricated material is slit, stamped and cold drawn for electro-galvanized electrical products such as switch boxes, outlet boxes and covers. The entire cleaning line operating cost, including all charges, is $3.00 per ton.

Another excellent operation located in Detroit is cleaning 14-in. wide x 0.1875-in. gage x 74-in. long hot rolled rim stock at 125 fpm. The cleaning line consists of a magnetic sheet feeder, powered roller feed table, an eight-wheel blast cleaner, and a powered roller runout table having a set of powered brushes for dust removal and a spray type oiler spaced in its length. The conveyor ends at an automatic stacker from which the stock is conveyed to the forming process in the manufacture of truck wheel rims. This installation is one of our latest and is producing scale-free sheets at well under $3.00 per ton. The cost of this stock purchased, pickled and oiled, was approximately $9.00 per ton over the base price.

Strip and sheet cleaning is only one application of the blast cleaning process now in operation throughout industry. Ingot molds are now being blast-cleaned between heats to improve the ingot's surface, minimize sub-surface defects and to control, to some degree, the propagation of fire cracks and spalling of the interior surfaces of the mold. Slabs and billets are being descaled to disclose surface defects for inspection. This allows removal of the defect with a minimum of metal loss and reduces labor and materials used for conditioning. Blast cleaning of wire rod and heavy bar stock for cold drawing is now an accomplished fact. It has eliminated pickling and made possible the combining of cleaning, coating, and drawing into one continuous operation. A better finished product is now being obtained with large savings in labor and transportation and reduced cleaning costs.

All types of steel structures exposed to corrosion or weathering will soon be constructed of steel shapes and plates which have been blast-cleaned. A large installation on this application will soon be cleaning beams, angles, channels and plates before fabrication. The cost of cleaning is very low and the maintenance on the finished structure will be greatly reduced due to the absence of mill scale and the excellent bonding qualities of the blast-etched surface for protective coatings.

All of these applications are important contributions toward cost reductions, conservation of raw materials, impressive reductions in acid pickling, and disposal of industrial wastes. We believe, however, that mechanical blast cleaning of continuous strip and cut-to-length sheet is by far the largest tonnage and offers the steel producer and processors of steel the greatest opportunity for dollar conservation.

Discussion

PRESENTED BY

ALFRED KRAUSE, Manager, Rolling Mills, Ford Motor Co., Steel Div., Dearborn, Mich.

GILBERT D. DILL, Process Engineer, Steel Div., Wheelabrator Corp., Mishawaka, Ind.

JOSEPH HORVATH, Superintendent Cold Strip Mill, Ford Motor Co., River Rouge Plant, Dearborn, Mich.

ROBERT SERGESON, Chief Staff Metallurgist, Jones & Laughlin Steel Corp., Detroit, Mich.

RAY MARX, Arnold H. Hughes Co., Detroit, Mich.

WILLIAM LILLY, Production Steel Co., Detroit, Mich.

Alfred Krause: What is the highest speed you have been able to attain for 48-in. wide strip in a continuous line?

Gilbert D. Dill: About 300 fpm. That is a matter of the number of wheels. The line that produces that rate has sixteen 40-hp wheels, each throwing around 1000 lb of abrasive per minute.

Now we have a new wheel which is connected to a 75-hp motor and throws 2000 lb per min. The machine that I mentioned in my paper is the new machine, which has eight 75-hp wheels and the same capacity as sixteen 40-hp wheels. However, you can go on up in speed. You can put in sixteen 75-hp wheels and get 600 fpm.

Alfred Krause: Is anybody thinking that far ahead now?

Gilbert D. Dill: Yes, we have already quoted such a machine.

Alfred Krause: How would a similar investment compare with a conventional pickle type 300 ft long? You are talking about a fairly large installation.

Gilbert D. Dill: It depends on the construction of the pickle tank. If you are using a steel tank, rubber-lined with acid and heat resistant brick lining etc., the mechanical blast equipment and the acid tanks cost about the same. If anything, the mechanical blast equipment might be just a little bit higher but not very much.

Joseph Horvath: Do you know approximately the size required for the same line we are talking about compared to a full pickle line, for example a mechanical blast equipment line that would be running 300 fpm? How many men would you need on a line like that?

Gilbert D. Dill: The mechanical blast equipment does not add any extra labor. It is automatic. It functions the same as an acid tank would function. The line in Mansfield has, I believe, six men and a foreman. It is a conventional pickle line and has three men at the front end, one to operate the feeder and scalebreaker, and one to operate the shear and welder. They also have one helper. The discharge end has one line operator and one coil bander and weight recorder.

Joseph Horvath: Then you would not need any special crew to run the blast cleaning equipment?

Gilbert D. Dill: No. In a good many mills we have been asked to design blast cleaning equipment to fit into their present line in place of an acid tank. Usually an eight 75-hp wheel machine is only about 70 ft long. This means that if you have, for example four 70-ft tanks, you could take out a couple of the tanks and still have adequate acid that will give the required 14 to 15 sec of acid contact. To clean at 300 ft, you would need about 240 ft of acid. With 70-ft blast equipment and a 60-ft acid tank you get the same results. If you put in more blast equipment and more acid, you can get higher speeds.

Robert Sergeson: Did I understand you to say that there was in operation a line-up for cold drawn bars in which you have the blast equipment in line with a coating process?

Gilbert D. Dill: We are building a machine right now. It is going to blast clean from one in. up to 4½ in. diam bar stock in cut lengths. We have designed an automatic feeder. All the customer has to do is lay the bars on skids in a flat layer, and our feeder picks them off in groups, ranging from a maximum of eight one-in. diam and a minimum of two 4½ in. diam. They go through the blast equipment where they are completely descaled, are removed to a conveyor which carries them through a tank where they are coated with a bond holder lubricant, and are conveyed out of the tank to the feed table ahead of the new draw-bench. This is a two-die bench designed to process 400 lineal ft of drawn bar per minute.

Along with this machine we are building five of our rod machines. These units make it possible to produce finished wire from hot rolled rod in one process line. In other words, we clean it, coat it, and draw it all in one operation. We are building another machine in a similar line, except drawing is followed by a bolt maker. We are going from the hot roll rod to a finished bolt in one continuous line without any handling.

Ray Marx: In regards to your strand line, do you encounter any difficulties with the coating of lime after blast cleaning because of the time element?

Gilbert D. Dill: We have three lines in operation in Cleveland, two of them originally put in with the lime coating tank and drier. The lime tank is about 4 ft long and the drier is about 3 ft long. The rod travels through them at 350 fpm.

Ray Marx: How does the lime hold if the stock is not hot?

Gilbert D. Dill: The lime was hot, and the rod warm; but the rough surface left on the rod by the blast cleaning equipment helps to pick up and hold the necessary lime for adequate coating.

Ray Marx: Could you get 300 fpm?

Gilbert D. Dill: Yes, they are doing it right now.

Ray Marx: What diameter is that?

Gilbert D. Dill: Up to 7/16 in. diam in this particular case. The diameter does not make any difference to us as far as cleaning is concerned, but it does affect the tonnage cleaning cost.

I might add that the newest thing in drawing wire is a phosphate coating.

Ray Marx: Is that done in a tube system?

Gilbert D. Dill: Yes, they do it in that manner. They have developed a phosphate coating which can be applied in eight to ten sec. They also have equipment for our high-speed single strand lines which will run up to 600 fpm.

Alfred Krause: I would like to get back to the hot

strip, hot band. Do you use the conventional scalebreaker in the coiling equipment?

Gilbert D. Dill: That particular line has what we call a single-roll processor with a five-roll level. Actually all we require is something to take the coil bend out of the sheet. We do not particularly need a scalebreaker. A good five-roll or seven-roll level will do the trick.

Alfred Krause: Is it necessary to do any kind of cleaning after scale removal, or is it necessary to give the strip a pickling wash?

Gilbert D. Dill: Only for steel that is going to be cold rolled.

Alfred Krause: Then you recommend a pickle wash?

Gilbert D. Dill: Yes, a 14 to 15-sec flash pickle is recommended. It has to do with removing something from the surface which breaks down in cold rolling and creates an undesirable smut. We have demonstrated that if that something on the surface is removed, you can roll it and get an exceptionally clean cold rolled steel. The blast cleaning process takes the scale off if you perform the operation properly. But there is still something left on the surface. We have a lot of theories and are working on them. We hope by the end of this year to be able to eliminate that 14 or 15-sec acid pickle.

Alfred Krause: Does it require a wash for phosphate coating?

Gilbert D. Dill: No. In the case of rod, it goes directly from the blast cleaning equipment into the phosphate coating tank.

Alfred Krause: Is that done in a tank?

Gilbert D. Dill: Yes, you can apply it after blast cleaning in the form of either a spray or dip tank or with squeeze rolls, without a prior wash.

Robert Sergeson: Did that stainless steel absorb the steel grit on the surface?

Gilbert D. Dill: We did not normally use steel grit. We use steel shot, and there is no imbedment of abrasive. We have blast cleaned stainless and tried to roll it without pickling. It rolled all right but it did not have the proper finish. It was not bright and lustrous, but dull. It was not stainless; it rusted. But a few seconds in nitric acid and hydrofluoric acid does the trick, and it rolls very well. The stainless people want to get a white color coming out of their cleaning line. They say that if they do not, they cannot get the proper finish on the steel. We tried it without acid, and it does not work so they must be right.

Willaim Lilly: Are any of the blast cleaning lines producing a No. 3 finish in cold roll quality?

Gilbert D. Dill: Empire Steel claims they have produced a No. 3 finish, but I doubt if it is the same. I think you are talking about a plating finish for chrome plate.

William Lilly: That is correct.

Gilbert D. Dill: No. However we have customers producing mirror finishes on blasted and flash-pickled chrome steel. It is actually a rolled finish and is just like a mirror. ▲

1959 AISE

SPRING CONFERENCE

Auspices of Rolling Mill Committee

April 27, 28, 29

The Statler-Hilton
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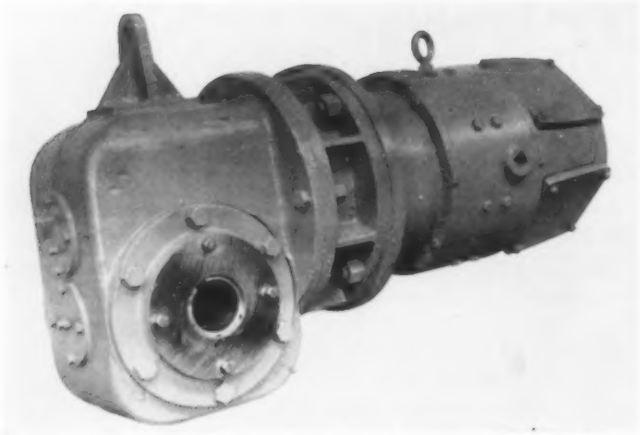

Figure 1 — This floating right angle gearmotor, which requires no coupling or special mounting base and whose alinement with the driven shaft is not critical, is a space saver when applied to table rolls.

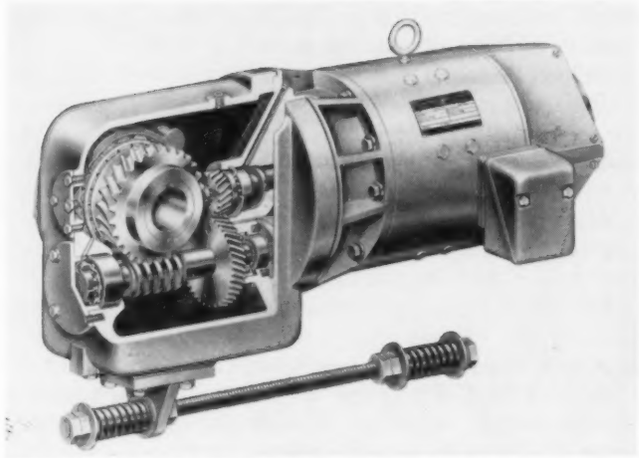

Figure 2 — The shaft to be driven is keyed into the hollow worm wheel of this double reduction floating right angle gearmotor.

Floating Right-Angle Gearmotors

by H. L. Olmstead, Application Engineer

and D. F. Wild, Manager, Design Engineering

Gear Motor and Transmission Components Dept., General Electric Co., Schenectady, N.Y.

Floating right angle gearmotors, when applied to individual table rolls instead of horizontal parallel shaft gearmotors, provide maximum gear ratio in a given space, are easily replaced, have heavy duty shock load capacity, and require less maintenance and floor space, no special mounting base or coupling, and only noncritical alinement with the driven shaft.

INDIVIDUAL gearmotor drives are increasing in popularity for use on table rolls whose speeds are 350 rpm and lower. In addition to a lower first cost for the installation, the gearmotor eliminates the maintenance and lubrication problems inherent in a line shaft and right angle bevel gear arrangement. At roll speeds below 200 rpm the first cost of the electric equipment, including roll drives, generators and control, strongly favors the use of individual gearmotors.

Parallel shaft gearmotors are generally flexibly coupled to the roll shaft extension. Any serious misalinement between the two shafts results in excessive coupling wear which imposes greater-than-normal loads on the gears. Such misalinement may be caused by faulty installation or by the physical abuse to which mill tables are normally subjected. In addition to the requirement for accurate shaft alinement, parallel shaft gearmotors, which must be mounted horizontally for table rolls, require special mounting bases and considerable aisle space for mounting.

The floating right angle gearmotor, shown in Figure 1, rides directly on the roll shaft extension and requires no coupling. Alinement is not affected by roll warpage or distortion. As a consequence this floating gearmotor has been applied to a variety of low speed steel mill roll tables, which involve frequent starting, stopping and reversing, as follows:

1. Intermediate cooling tables of hot strip mills.
2. Conveying tables of rolling mills such as plate, structural pipe and merchant mills.
3. Saw tables of hot steel billet mills.

This floating right angle gearmotor is available in both single and double reduction gear types. An illustration of the two stage reduction type is shown in Figure 2. The low speed, second stage gearing utilizes a worm and a mating worm wheel whose hollow wheel shaft allows the entire gearmotor to mount directly on the roll shaft extension and to float with the roll. Some of the advantages of this type of drive, which are readily apparent, are:

1. Costly alinement problems at installation are eliminated.
2. The drive cannot be wrenched out of line by bending of the roll.
3. Mounting bases and couplings are eliminated with a saving of space.
4. Replacement of entire drive, should motor or gear failure occur, is a rapid and relatively easy operation.
5. The only mounting provision necessary is for a simple cushioned torque arm to balance the output gear torque.

The compactness of this floating drive is readily seen in Figure 3. Note how the vertical position of the

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This zone-fired type of Rust furnace is used by virtually all strip mills throughout the world. Rust also builds all other types of metallurgical furnaces, designed for any fuel. Consult us about your requirements.

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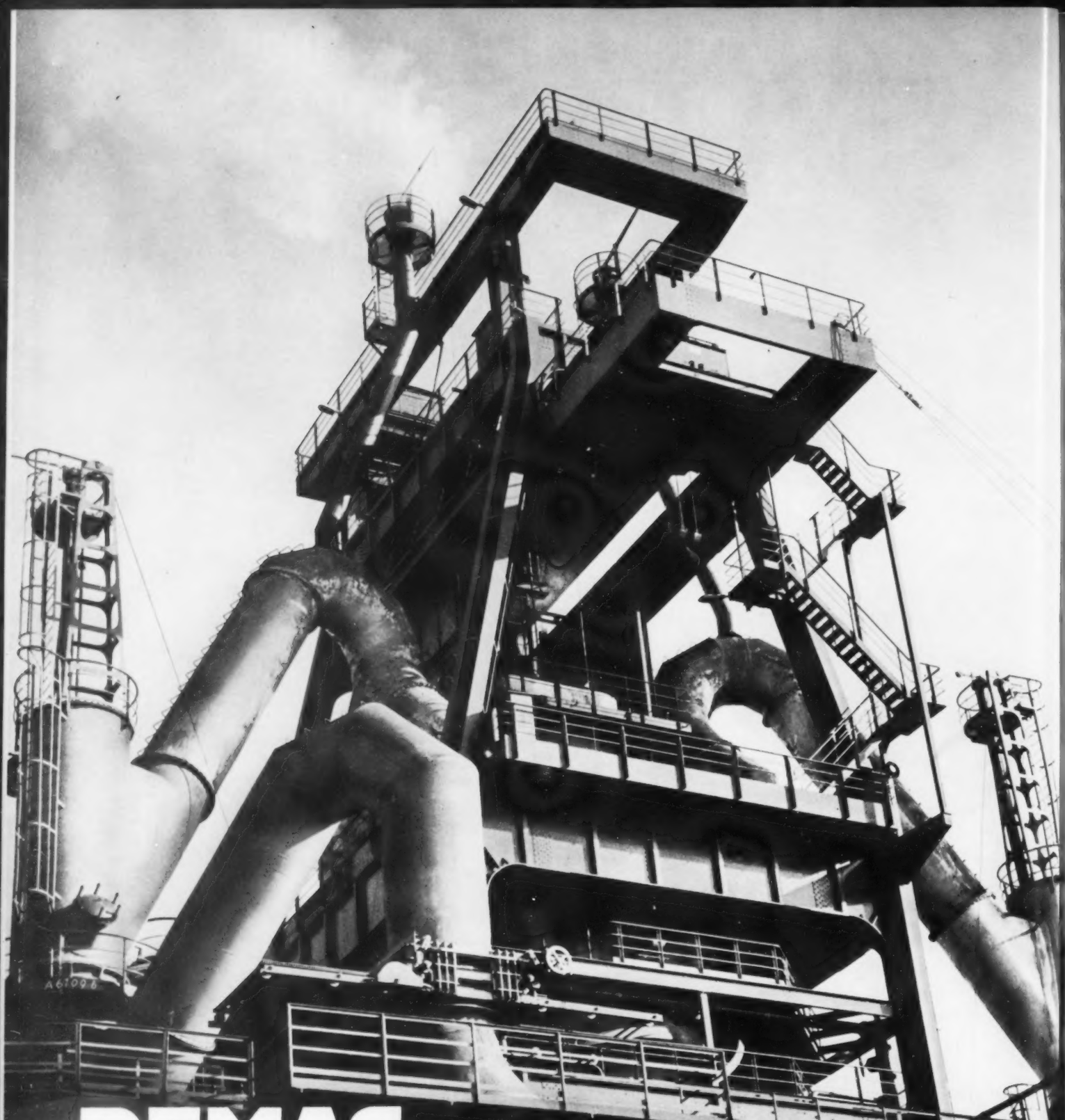

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motor and its location below the gear output shaft and roll centerline saves valuable space in this saw table application. Another important advantage of this vertical motor construction is its position out of the way of damaging blows from slabs, magnets, crane hooks and the like.

Retention of lubricant in the gear housing on vertical motor applications must be given special consideration as any leakage at the rotor shaft aperture may result in damage to the motor windings. Consequently, a dry well type of sealing is re-enforced by two secondary seals to assure long trouble free service. An integral force fed lubrication system carries lubricating and cooling oil to the uppermost bearings and gears on double reduction units. Gear and bearing lubrication on single reduction units are achieved by direct dipping of the worm wheel into the oil sump. Should oil leakage occur after long service, a relief hole located below the input shaft seals allows maintenance personnel to immediately detect leakage at this point. Motor rotor bearings in both single and double reduction gearmotors are grease lubricated and have provision for relubrication when necessary.

Should roll spacing be wide enough to permit the gearmotors to be mounted horizontally; i.e., a motor positioned horizontally between the rolls, then provision for force fed lubrication and special sealing arrangements are not required.

The floating right angle gearmotor is available in both a-c and d-c horsepower ratings ranging from one to ten hp. D-c motors, the usual standard of the industry, may commutate up to 500 per cent rated torque to provide minimum acceleration and deceleration times for the rolls. Gears, of course, must be capable of transmitting the torque peaks that the motor is asked to deliver. Unlike a motor which can be selected on a root mean square torque basis, gear teeth must be proportioned to safely handle the maximum peak loads involved.

The output stage of both single and double reduction floating gearmotors is composed of a heat treated alloy steel precision ground worm driving a chill cast alloy bronze worm wheel. Worms and worm gears are inherently capable of withstanding heavy duty shock loads of a repetitive nature. These inbuilt strength characteristics qualify this gear type for rugged mill service. In the double reduction units an offset stage of helical gearing forms the first stage of reduction. Heat treated, shaved gearing of ample proportions enable this gear set to withstand the shock loads encountered in mill roll drives.

The worm and wheel gear set of either single or double reduction units is usually built in a gear ratio below 12 to 1 as a compromise between maximum gear efficiency, economics of manufacture, and the need for nonlocking. A nonlocking or reversing worm wheel set is one which can be rotated by applying torque to the worm wheel shaft. This particular feature is necessary in the case of individual motor failure. Without it, a stalled roll would lock in place and become scored or burned from contact with passing billets.

A typical floating drive application has been installed at the Copperweld Steel Co. plant in Warren, Ohio. Figure 4 shows an over-all view of this saw table using floating right angle gearmotor drives. These saw table drives are required to accelerate the individual rolls and the hot bars to running speed, move the bars a prescribed distance, and stop. The bars are then positioned for the cutting operation. In addition, the drives jog an average of once per front crop cut and once per back crop cut. During the cutting portions of the operation the drives are at rest.

The worst case of torque loading on the drives occurs when cutting 122-ft lengths of 5-in. diam bars into 15-ft lengths. For this particular set of conditions, three saws are spaced at 15-ft intervals along the table, and three cuts to length are made simultaneously as given in Table I.

TABLE I

Operation	Length of cut (ft)	Electrical cycle
1. Crop cut front end	0	2 starts and stops
2. Run bar to gage and cut three pieces	45	1 start and stop
3. Run bar to gage and cut three pieces	45	1 start and stop
4. Run bar to gage and cut remainder	32	1 start and stop
5. Crop cut back end	0	2 starts and stops

This total cycle requires 90 sec to complete. Although the average torque required during acceleration was only 125 per cent of rated motor torque, the gears were designed to handle frequently repeated 200-per cent torque load peaks which the motors can easily produce at base speed.

Individually powered rolls were specified instead of line shaft drives for this application because rolls and their drives must be removed or added to the table as the saws are moved closer together or set further apart.

Space considerations dictated the use of vertically mounted motors which are controlled from a constant potential auxiliary control panel that provides for both reversing and dynamic braking functions.

Gearmotor specifications for this saw table, a part of a 20-in. reversing billet mill, were as follows: Thirty-

Figure 3 — This saw table application of floating right angle gearmotors illustrates the compact installation they afford.

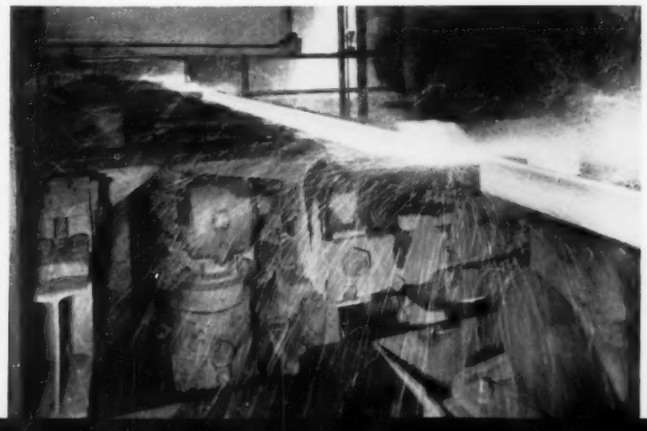


Figure 4 — Floating right angle gearmotors drive the table rolls of the hot bar table saw at the Copperweld Steel Co. in Warren, Ohio.

three 2-hp, 1150/2300-rpm 240-v d-c, totally enclosed, nonventilated, 75 C rise continuous, shunt wound, 240-v vertical floating right angle gearmotors with separately excited fields and 115/230-rpm output speeds suitable for reversing service and frequently repeated 200 per cent loads, Class III service. Each unit is to be furnished with steel housing, a torque arm, a small conduit box, standard length leads, and be of water-proof construction.

Floating drive types, in general, have had considerable appeal since the development of the floating motor in the early 1940's. Although the application of floating roll drives is not unique, the floating right angle gearmotor provides a definite contribution to the mill building art, particularly when consideration must be given to such items as:

1. Individual roll drives.
2. Length-wise space.
3. Rapid and simple replacement.
4. Lower maintenance costs.
5. Heavy duty shock load capacity.
6. Maximum gear ratio in a given space.

In addition, both the performance and reliability of the floating right angle gearmotors are being proved daily as old and new installations realize their inherent advantages.▲

Standard Steel Works Installs Facilities For Specialty Steel

AN electric furnace, ingot-cooling and heat-treating furnaces and the latest laboratory testing facilities for quality control have enabled Standard Steel Works Division of Baldwin-Lima-Hamilton Corp. to speed deliveries of high alloy steels during the past year.

Installed early in 1958 as part of a continuing modernization program at Standard's plant in Burnham, Pa., these facilities have expanded the versatility of manufacturing capabilities, broadened product lines, increased quality and slashed delivery times.

Prior to this installation, Standard did not make its own specialty steels. This was a severe drawback.

The electric furnace facility now permits Standard to make and process such specialty steels as these:

1. Bearing grade steels, such as SAE 52100 used in custom bearing applications.
2. Tool steels for use in dies and for high-strength, high-temperature applications in supersonic flight.
3. Stainless steels for applications requiring corrosion resistance, such as flanges and forgings for chemical and petroleum processing plants and nuclear reactors.
4. High-temperature steels for jet engines and steam piping applications and for alloy castings.

Preliminary planning for the furnace installation began in 1955, when forecasts indicated increasing demands for higher alloy steels. Because of the predicted emphasis on such higher alloys, installation of an electric furnace was essential.

The furnace has an 11-ft shell and a capacity of 12,000 to 30,000 lb. To accommodate it and associated facilities, considerable plant modification was required—including extension of building foundations, relocation of walls and installation of an entirely new ingot-mold storage area.

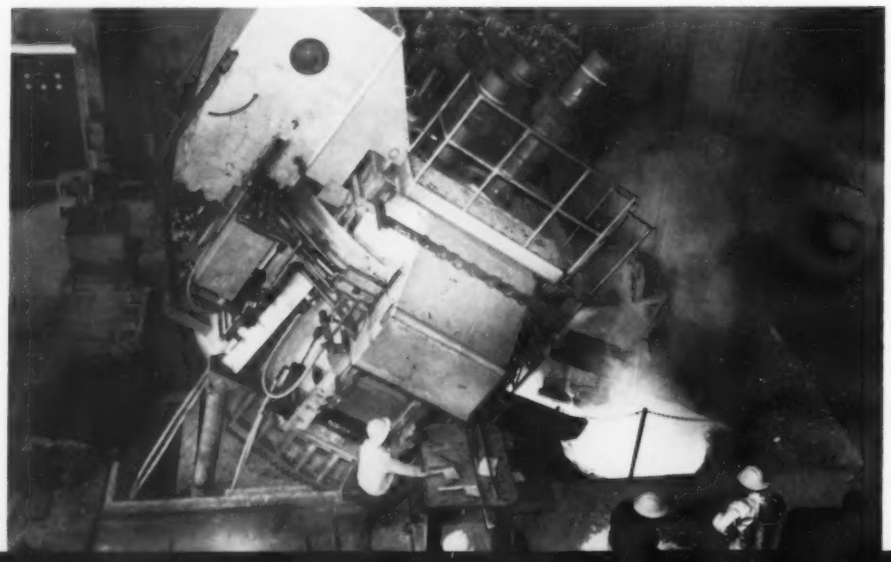
Other modifications included a completely revamped electrical distribution system, compatible with the existing network and providing flexibility of operation. Such requirements were met by installing a set of twin transformers rated at 7500-kva each—one for the furnace exclusively, the other for normal plant load. In case the plant transformer failed, however, the furnace unit could be used to carry plant load.

To maintain the required chemical control of steels made in the electric furnace, a new x-ray spectrometer was added in the metallurgical laboratory. It provides precise control of analyses of higher alloy steels through its more accurate breakdown of components in a large sample.

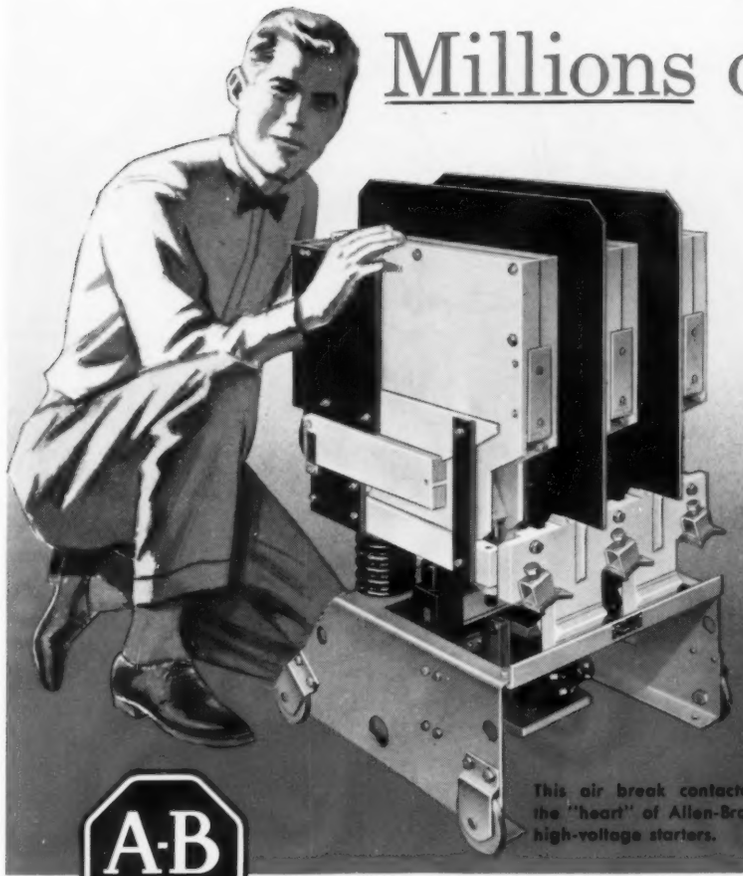
Heat-treating equipment also was completely modernized. Seven new furnaces were installed, two of which accommodate the largest ring—6000 lb and 14 ft in diameter—that can be rolled in Standard's ring mill. These furnaces are equipped with programming that permits controlling the temperature of the steel completely and automatically throughout the various stages of treating.

Supplementary to the heat-treating furnace, new oil- and water-quenching systems were added which also can handle the largest rings made at Standard. Three new ingot-cooling furnaces also were installed which provide automatic control of temperature during cooling of ingots to eliminate internal defects. ▲

Figure 1—Pouring a high alloy steel heat nears completion at Standard Steel Works as electric furnace foreman (left) operates hydraulic controls which tip the furnace.

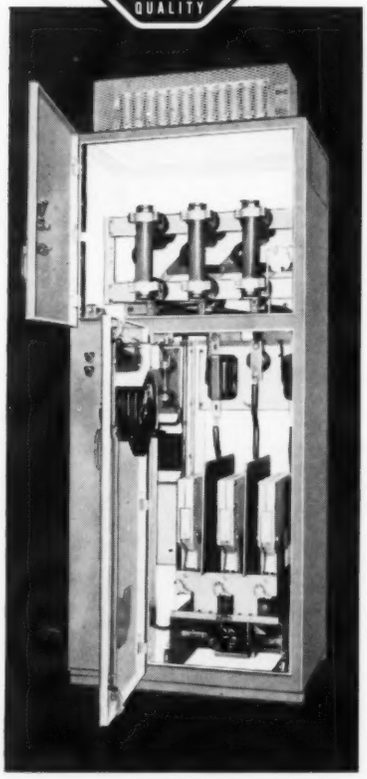


You Can Expect Millions of Trouble Free Operations with Allen-Bradley High-Voltage Air Break Starters



This air break contactor is the "heart" of Allen-Bradley high-voltage starters.

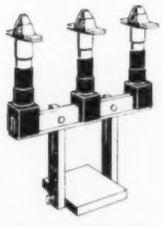
A-B QUALITY



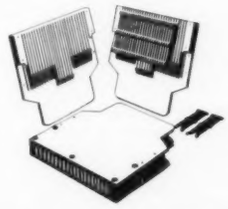
Bulletin 966 high-voltage air break across-the-line synchronous motor starter in NEMA Type 1 enclosure. All A-B high-voltage starters are equipped with current limiting fuses.

For the steel industry—where tough jobs are the normal routine—there's nothing to match these A-B high-voltage starters. Their simple solenoid contactor—with only ONE moving part—assures an operating life that will *amaze* even the most skeptical. The silver alloy contacts are always in perfect operating condition—no filing or "dressing" is necessary.

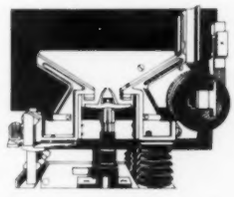
These new air break starters are made for all types of motors and for every service—up to 1500 hp, 2300 volts; 2500 hp, 4600 volts. Get the complete story. See how it is possible for these A-B starters to take the punishment of frequent switching, jogging, and plugging. Send for Publication 6080.



Only One Moving Part
Simple solenoid design eliminates trouble-causing pins, pivots, and flexible jumpers.



Faster Arc Suppression
New blowout design and unique arc chute. Chutes are molded from a new arc resistant material.



Double Break Contacts
of silver alloy never need maintenance. Vertical motion assures uniform contact pressures.

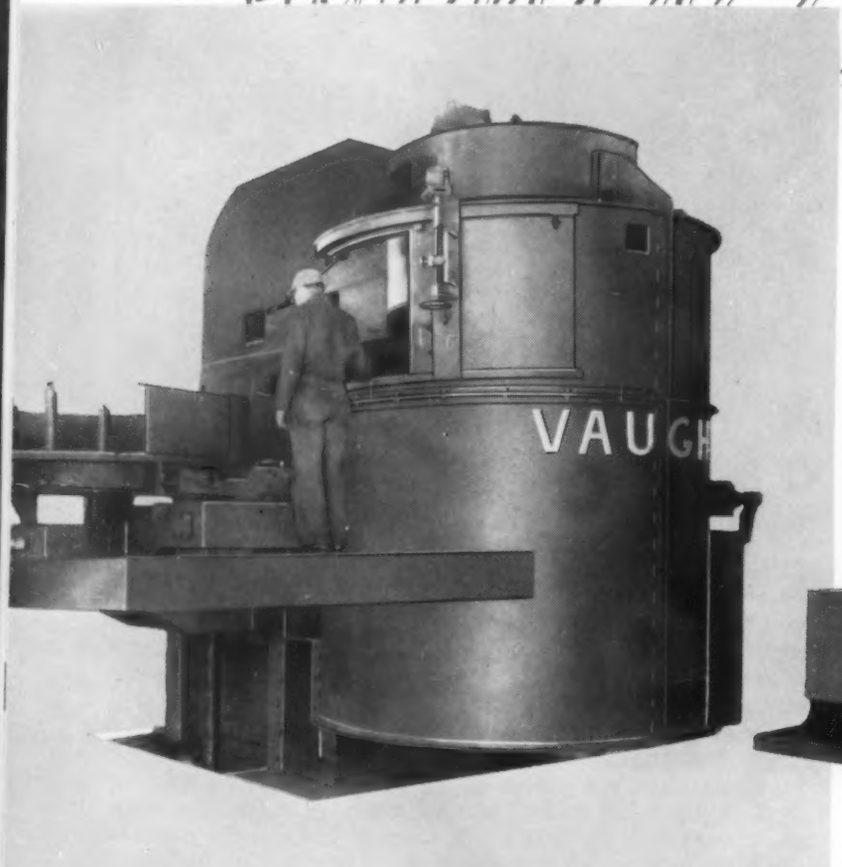
Allen-Bradley Co., 1343 S. First St., Milwaukee 4, Wis.
In Canada: Allen-Bradley Canada Ltd., Galt, Ont.

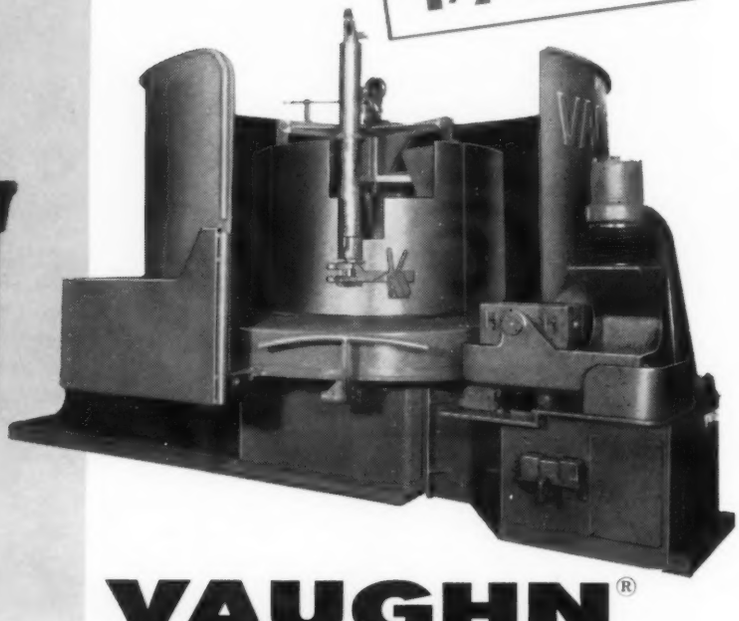
ALLEN-BRADLEY
QUALITY
MOTOR CONTROL

HERE'S *high speed* PRODUCTION OF *long*

THIN WALL TUBING IN COILS

1½" TO ¼"





VAUGHN® TubeBLOC®

For copper or aluminum tubing, Vaughn TubeBloc machines start at 1½" dia. maximum tubing and will finish down to approximately ¼" dia. minimum. 60" diameter blocks run at speeds up to 2,000 ft. per min. ● With the **Vertical Type** (above, right), length of tubing is not limited by the diameter and length of the block. Finished bundle is removed by block stripping spider. ● With the **Inverted Type** (above, left), length of tubing is governed by diameter and length of block. No block stripping spider is required. Convolutions of tubing are laid side by side from top to bottom of block by traversing die holder mechanism.

Ⓥ®

"Quick on the Draw!"

THE VAUGHN MACHINERY COMPANY

Cuyahoga Falls, Ohio, U. S. A.

COMPLETE COLD DRAWING EQUIPMENT . . . Continuous or Single Hole . . . for the Largest Bars and Tubes . . . for the Smallest Wire . . . Ferrous, Non-Ferrous Materials or their Alloys.

Draw your thin-wall tubing in *long* lengths . . . in easy to handle coils . . . conveyorized to speed production flow . . . *and you're in step with the best!* Use either the Upright or Inverted VAUGHN TubeBloc as required by your conditions, and profit by speeds up to 2000 fpm—in finished sizes from 1½" to ¼". Consult us, without obligation.

Contractor Raises Roof at J&L

A UNIQUE construction technique is being used in the installation of the modern high-speed continuous annealing line at the Aliquippa Works of Jones & Laughlin Steel Corp. The new line, one of the latest developments in the production of quality tin plate, includes a 75-ft high vertical annealing furnace. Since the new line is being installed in the tin plate department's No. 4 cleaning building, which has a roof only 55 ft high, the roof had to be raised to accommodate the furnace and a crane over it.

Ragnar Benson Inc., Pittsburgh, prime contractor for this portion of the project, is accomplishing the building alterations without interruption of production on the tin-plate cleaners, and without exposing the interior of the building to weather.

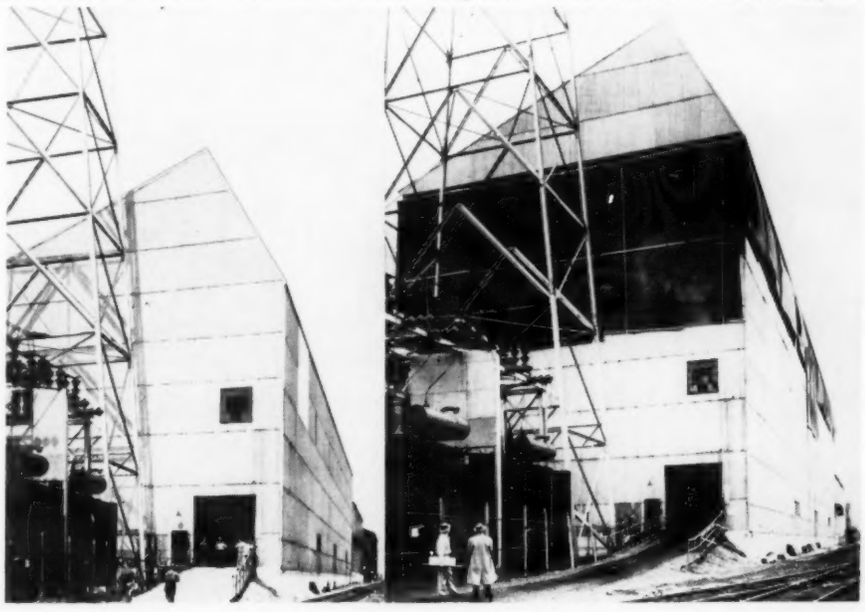
Fort Pitt Bridge Works, Canonsburg, Pa., sub-contractors to Ragnar Benson, are raising the roof a total of 36 ft in what is believed to be the greatest distance ever attempted in a technique of this type.

The roof is being raised in increments of 12 ft by 28 hydraulic jacks, placed at each supporting column around the building which is 350 ft long and 80 ft wide. As each 12-ft increment is reached, new column extensions are added to the existing columns, and the side sheeting is installed to keep the building closed from the weather.

A substantial savings in time and money will be realized by utilizing this technique instead of removing the roof, adding the required height, and then rebuilding the roof. The technique also permits continuous operation of the cleaning lines.

The system works as follows:

Figure 1—The Roof of this building is being raised a total of 36 ft, without interruption of production facilities. The view at left shows the building before the project was started, while the one at right shows the roof almost 20 ft higher.



The hydraulic jacks first were placed on supporting platforms at 28 columns around the building, a rigid frame was installed at the roof structure, and temporary rams were placed down the face of existing columns.

The 28 jacks, each with a 6-in. stroke, are elevated simultaneously in 2-in. movements at the base of the rams by employees who act on a whistle signal. The position of the building and roof are checked after each 2-in. move.

As the roof is raised 6 in., the existing columns are bolted to the temporary rams, and the hydraulic jacks elevated to new positions on scaffolds.

The building is kept in line by steel yokes. One yoke is fixed to the bottom of the ram near the jack and travels with the ram up the face of the building column. The second yoke is fastened at the top of the existing building columns. It remains stationary while the ram passes through.

The roof will be raised approximately 6 ft per 8-hr day.

The new continuous annealing line has been engineered to operate at speeds up to 2000 fpm in a combination cleaning-annealing operation. This operation imparts to the strip steel an extremely uniform degree of physical properties suitable for a wide variety of tin-plate uses. The line is the first of its type designed with co-ordinated mechanical and electrical drives throughout the equipment.

It will be able to handle coils weighing up to 50,000 lb and up to 38½ in. in width. Its capacity, at top operating speed, will be 30 tons of tin plate per hour. ▲

A message of interest to users of Solenoids

This amazing consistency is due to BUSS Engineering.

DETROIT COIL COMPANY
Manufacturers of Direct Industrial Solenoids

DETROIT 20, MICHIGAN

Sept. 29, 1958

Bussmann Mfg. Division
McGraw-Edison Company
St. Louis 7, Mo.

Gentlemen:

In the development of any product, accelerated endurance tests are of the utmost importance. Since our test facilities run unattended for a considerable period of time, it was always an unknown factor when a breakdown occurred; and whether the breakdown was the result of an electrical or a mechanical cause. Since our introduction of Fusetron fuses to this test equipment, we have eliminated this unknown.

For this test work, we need a protective device permitting normal operation of the solenoid, but in the event of mechanical or electrical breakdown, stop the test at a stage where the cause for failure could be examined before the evidence was destroyed.

Approximately two years ago, we started using Fusetron fuses on these tests. We found them to have an amazing consistency in their rating. Since then, where the proper size Fusetron fuses were used, it has been possible for us to determine the direct cause of electrical breakdowns.

We believe that if Fusetron fuses of proper size were generally used in the field, a great deal of coil replacement could be avoided — and resultant costly shutdowns, required while a solenoid is being repaired or replaced, would be eliminated.

This would be a boon to our service department, too, as it would cut down the number of service calls we have to make where the problem is not directly due to failure of the solenoid.

We feel that general use of the Fusetron fuse protection for solenoids would help both our customers and ourselves.

The size Fusetron fuse we use on normal applications is generally about 125% of the holding current rating of the solenoid.

Yours very truly,

DETROIT COIL COMPANY

E. A. Viale

E. A. Viale
Vice President

EAV-g

"A Great Deal of Coil Replacement could be avoided, and Resultant Costly Shutdowns Eliminated by Protecting Solenoids *with* FUSETRON FUSES."

E. A. Viale, VICE PRESIDENT
DETROIT COIL COMPANY

Protecting solenoids or other electrical equipment with FUSETRON Fuses—gives you greater safety, dependability and money-savings!

New!

The BUSS Add-On Fuse Block for the protection of solenoids or Small Motors on Multi-Circuit Equipment

The BUSS Add-On fuse block makes it easy to protect equipment of any kind where a number of solenoids or motors are used.

Blocks are made up of single pole fuse blocks that interlock into a unit fuse block of any number of poles.

Poles may be added or removed . . . to either end of assembled fuse block. This makes it simple to have a fuse block of just the number of poles needed and to fit the block to available space.

Each fuse can be used as a circuit disconnect.

Specially designed fuse clips permit one end of fuse to be removed from clip and fuse raised to right angle to block where it is held firmly in position — see picture above.

When working on machine this makes it quick to identify circuit that is open — and it assures that proper fuse will be put back in right circuit.

Write for BUSS Bulletin BL-1.

BUSS and FUSETRON fuses are available to fit these fuse blocks in ampere sizes up to 30 and for voltages up to 250. Write for BUSS Bulletin SFB.

FUSETRON dual-element fuses provide 10 point protection against electrical troubles—unlike circuit breakers or ordinary fuses which, except in rare cases, protect only against short-circuits.

Fusetron Fuses remain safe — with no maintenance or recalibration required. They are calibrated at the factory by engineers. Once properly installed, they require no inspection and resulting downtime necessary on mechanically operated devices. There are no hinges, pivots or contacts to stick or get out of order. Dust, corrosion or oxidation cannot increase a Fusetron fuse's capacity or lengthen its blowing time.

After years of inactivity, a Fusetron fuse will give the same safe, dependable protection if called upon to open as it would have on the day it was installed.

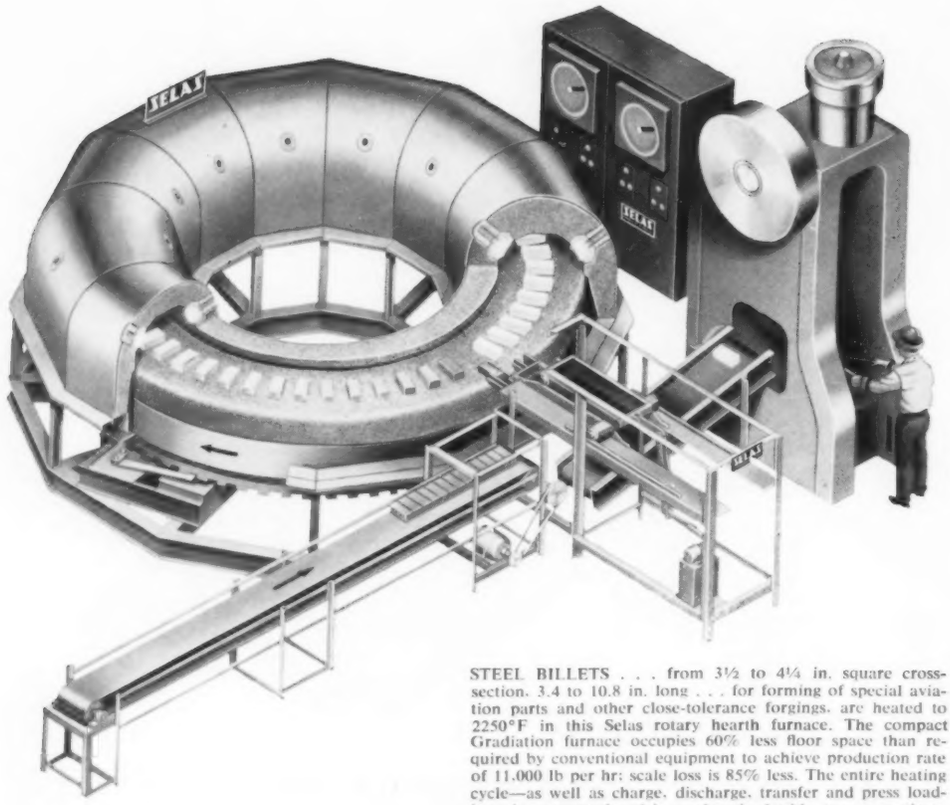
For more information, write for . . . Bulletin FIS on Fusetron Fuses.

Bussmann Mfg. Division, McGraw-Edison Co., St. Louis 7, Mo.

159

Play Safe! Install Fusetron dual-element fuses throughout entire Electrical System.

FUSETRON
TRUSTWORTHY NAMES IN ELECTRICAL PROTECTION
BUSS
McGRAW EDISON
BUSSMANN MFG. DIVISION · St. Louis 7, Mo.



STEEL BILLETS . . . from 3½ to 4¼ in. square cross-section, 3.4 to 10.8 in. long . . . for forming of special aviation parts and other close-tolerance forgings, are heated to 2250°F in this Selas rotary hearth furnace. The compact Gradiation furnace occupies 60% less floor space than required by conventional equipment to achieve production rate of 11,000 lb per hr; scale loss is 85% less. The entire heating cycle—as well as charge, discharge, transfer and press loading—is automated and is synchronized with press operations.

SELAS Gradiation®: Precise Heat Processing for the Steel Industry

Throughout the steel industry — in mills and metalworking plants — Selas Gradiation heat processing is successfully used in many operations. The versatility and adaptability of the Gradiation principle are demonstrated by the diversity of applications shown in the installation photographs on facing page.

Gradiation is a concept and technique of heat processing which coordinates fast, controlled heating with the nature of the workpiece . . . considering its composition, size, shape, heat transfer characteristics and physical properties . . . to develop desired product quality, in minimum time, with maximum efficiency, and with the use of automatic and compact equipment.

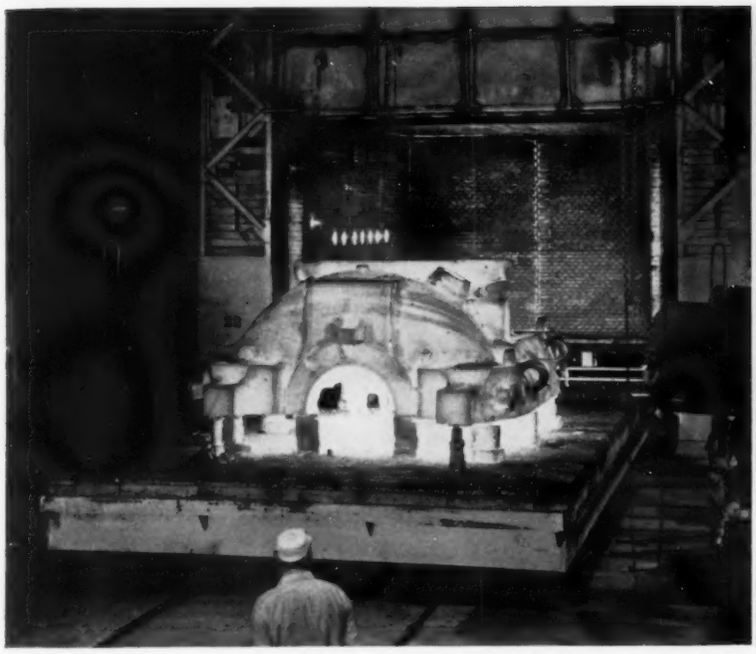
Designed and custom-built to meet your specific heat processing needs . . . for hot working . . . galvanizing . . . tinning . . . heat treating heavy sections and special shapes . . . Gradiation equipment contributes production economy, high production rates, ease of handling.

Selas Engineers will be pleased to discuss your heat processing needs with you and to show you how Gradiation can be adapted to your particular requirements.

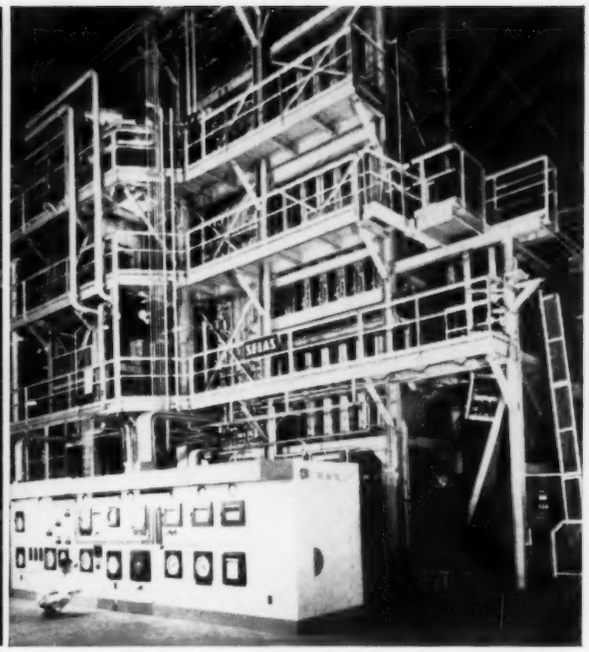
Send for our new 28-page Bulletin No. 42 "Selas Gradiation Heating in the Steel Mill" and article reprint "An Economic Appraisal of Continuous Heat Processing."

SUBSIDIARIES: Selas Constructors, Inc., Houston, Texas; Selas Corporation of America, European Div., S. A., Pregny, Geneva, Switzerland. **INTERNATIONAL REPRESENTATIVES AND LICENSEES:** BENELUX, FRANCE—Cie Gle de Construction de Fours, Paris; CAMBODIA, FORMOSA, KOREA, LAOS, VIETNAM—Casa Export Co., Inc.; AUSTRIA, GERMANY—Indugas, Essen; JAPAN—International Machine Co., Ltd., Tokyo; ITALY—Italiana Gasogeni E. Forni S.r.l., Milano.

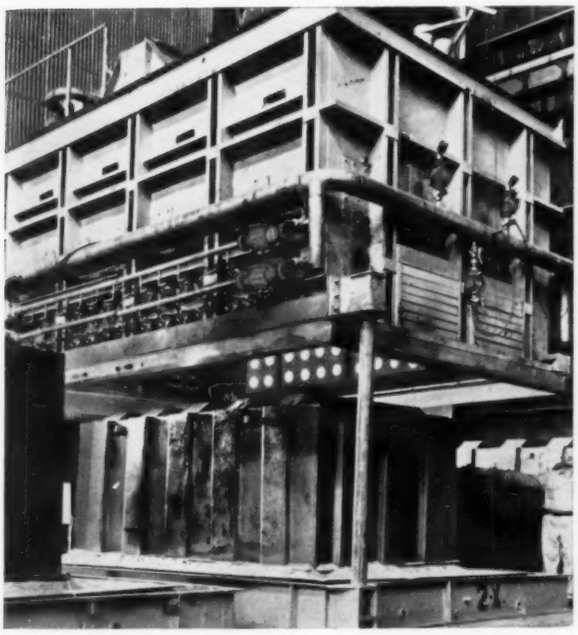
is your reward



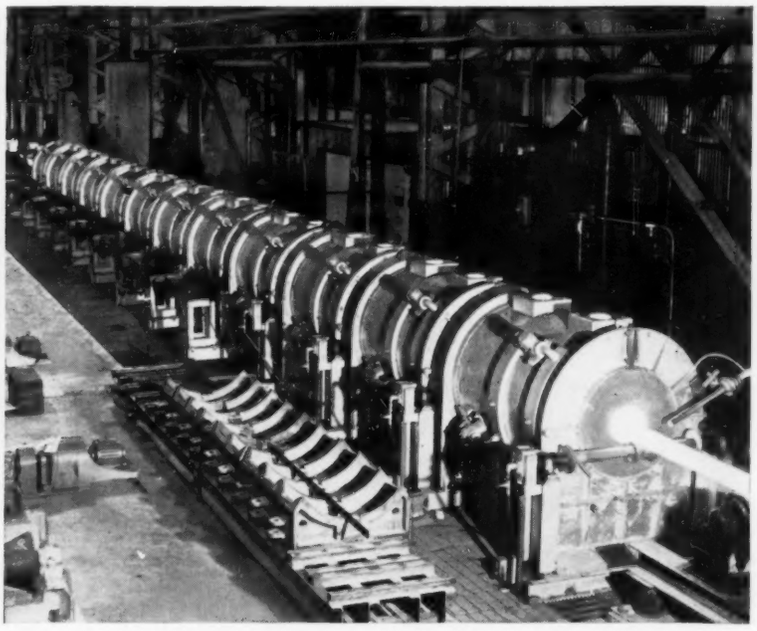
CASTINGS of high alloy steel are hardened and toughened in this Selas Gradiation-fired car-bottom furnace. Picture shows 35-ton turbine shell casting after heating to 1925°F and held at temperature for 10 hr. Turn of a valve converts furnace into lower temperature unit for reheat following air-cooling of casting. Time cycle required for this operation has been reduced 20% through fast heat-up and control possible with Gradiation heating. This type of furnace also is used for heating rolls and die blocks, and is ideally suited for heating sensitive steels as well as such non-ferrous workpieces as molybdenum and tungsten ingots.



STRIP is continuously bright-annealed in this 15 ton/hr, single-pass, direct-fired furnace. Four such compact lines, installed across a standard mill building, provide an eastern steel mill 400,000 tons per year increased capacity. Another installation produces 30 tons/hr; even higher rates can be readily attainable. Designed for fast, uniform heating, Gradiation strip lines are compact, easy to install, simple to operate, economical to maintain. Front panel of control cubicle functionally delineates entire process.



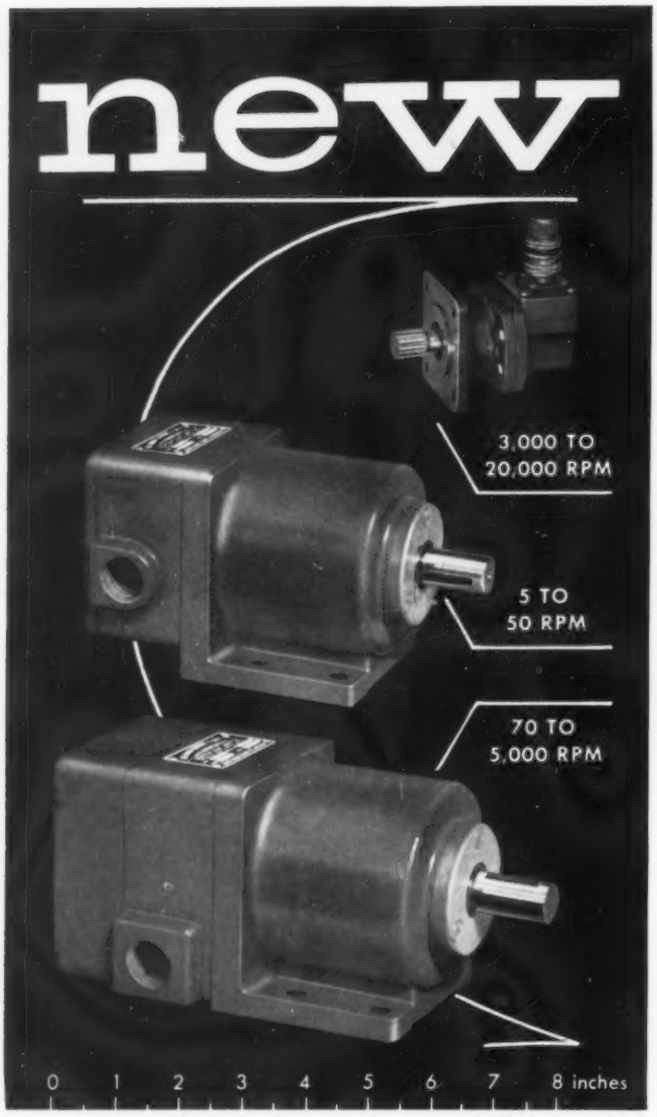
STACKED COILS of steel strip, as well as stacked sheets, weldments, castings and rolls, are batch-annealed in this Gradiation-heated cover furnace. Used as the "shop work-horse," this furnace accepts charges up to 42 tons—of wide diversity in size and shape—with maximum production of one ton per hour and using coke-oven gas as fuel. Duradiant burners fire directly on liner, providing even heat distribution. Burners are set flush in furnace wall to avoid maintenance problems.



TUBING . . . is normalized and, if required, stretch-reduced in this Selas barrel-furnace line. After forming and welding, the tubing is conveyed through a 48-barrel normalizing line with exit temperature approximately 1650°F. Stretch-mill product proceeds through additional 12 Gradiation furnaces which heat tubing to 1800°-1850°F. Entire process is completely automated.

Gradiation and Duradiant are registered trade names of Selas Corporation of America.

SELAS *Heat and Fluid Processing Engineers*
CORPORATION OF AMERICA
DRESHER, PENNSYLVANIA
DEVELOPMENT • DESIGN • CONSTRUCTION

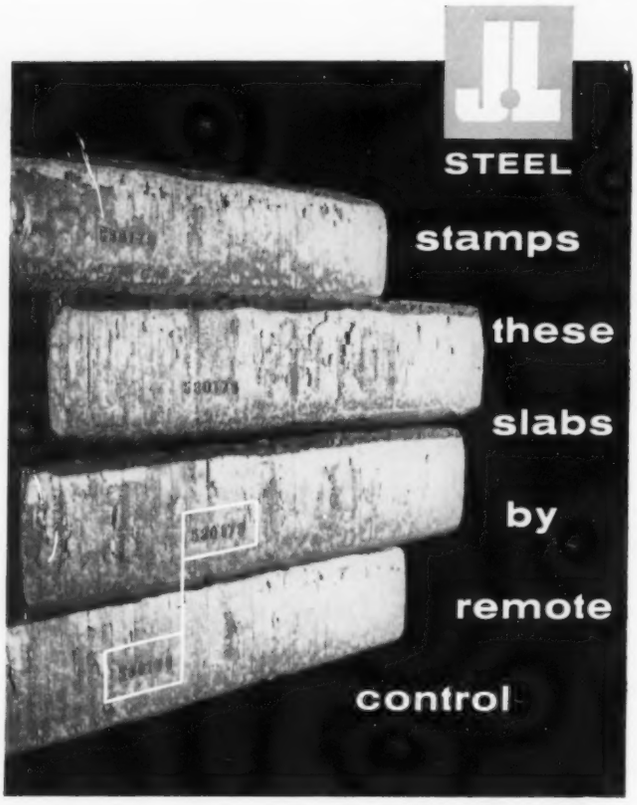


SPEED-RESPONSIVE SWITCHES

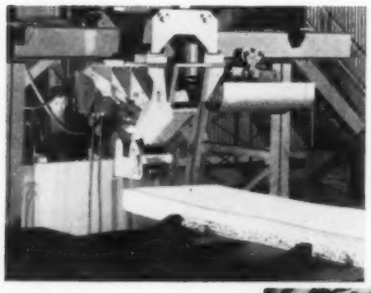
These control-circuit switches, depending on the type, are responsive to changes in speed from 1¼ to 20,000 rpm and direction of rotation. Contact adjustment may be made while running. Rugged construction, several contact arrangements and consistent accuracy make them suitable for applications such as zero-speed or plugging switches on machine tools, as over-speed or under-speed switches on rotating machines and drives of all types, as anti-plugging switches on machinery with inertia loads and as interlocking switches for conveyor systems. Ask for descriptive Bulletins 2210, 2220 and 2230.

THE EUCLID ELECTRIC & MFG. CO.
MADISON, OHIO

THE EUCLID ELECTRIC AND MFG. CO., MADISON, O. EUCLID

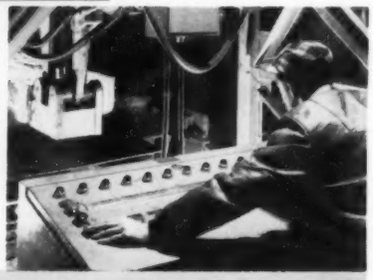


Deep, clear-cut, even impressions in slabs and blooms—*it's being done by remote control* at the 44" Blooming Mill in Jones & Laughlin's Aliquippa Works. This machine does the job better, faster, more economically, more safely than hand methods previously used. *Write for new bulletin on Remote-Control Marking.*



Slab in position for stamping with pneumatically-powered marking head. Both blooms and slabs are marked by the machine at J & L.

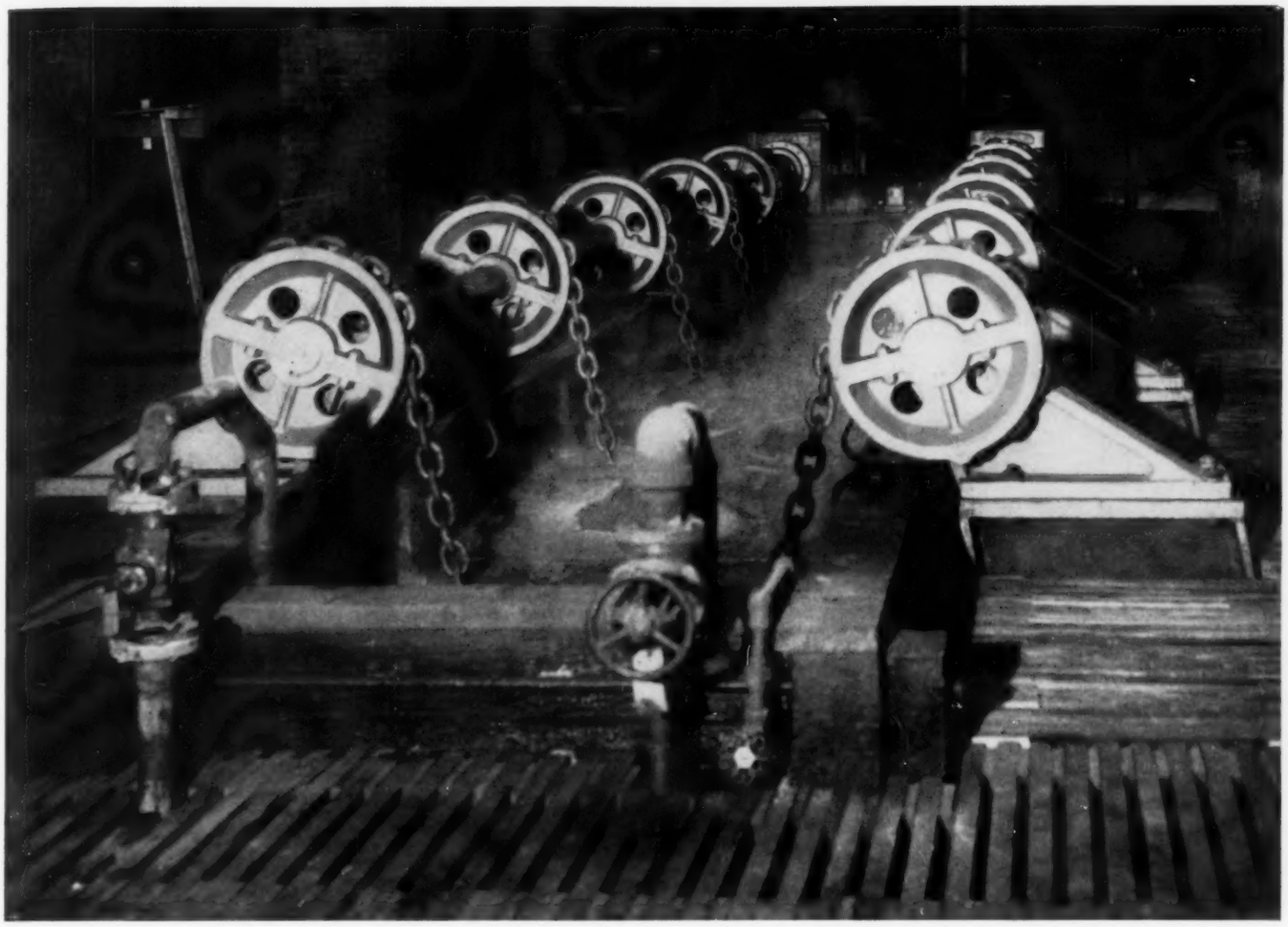
Any of the nine numbers in the marking head may be changed by pressing buttons on this control panel. A single button also actuates the stamping cycle.



Mecco SAFETY MARKING TOOLS

Model 701-RCW
SLAB MARKER
A Product of the Marking Device Industry

M. E. CUNNINGHAM CO.
1041 CHATEAU STREET, PITTSBURGH 33, PA.



Leading Steel Corporation's 7 WELDCO Mechanical Bar Picklers

Increase Tonnage—Cut Costs—Improve Quality

In 1952, the Cold Drawn Division of a large Mid-western steel producer purchased a WELDCO Bar Pickler for their Beaver Falls, Pa. plant . . . and since that time, *four* more have been installed in various other plants. In addition, the parent company installed two similar machines in their Canton, Ohio Bar Mills.

These patented Bar Picklers save 40-60% pickling time by combining the advantages of both mechanical agitation and chemical action. Increased output per tank reduces labor and acid consumption per ton, with a corresponding reduction in acid disposal cost.

In addition, these WELDCO Bar Picklers do a better, more uniform descaling job on rounds, hexes, squares, and flats up to 7" wide — without racking! Let WELDCO engineers show you how to improve your pickling operations and cut costs, too. Write or phone us today.

The Youngstown Welding and Engineering Company

WELDCO

3700 OAKWOOD AVE., YOUNGSTOWN 9, OHIO

DREVER

ROLLER HEARTH *bright annealing* FURNACES

Installed at the plant of Sawhill Tubular Products, Inc.

Shown above:

Controlled Atmosphere Furnace, Radiant Tube, Gas-Fired

Capacity, 3,000 #/hour

Alloy Tubing ⅛" O.D. to 2½" O.D.

Overall, 176 ft. long x 7'-6" wide

Also Available:

Gas or Electric Furnaces for Stainless Steel Annealing with or without Controlled Atmosphere

For carbon and alloy steel parts bars or tubing

DREVER COMPANY

RED LION RD. & PHILMONT AVE.
BETHAYRES, PA.

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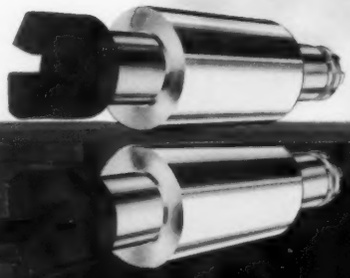

FROM SLAB

TO FINISHED STRIP

PHOTO COURTESY JONES & LAUGHLIN STEEL CORPORATION

At Jones & Laughlin's Cleveland Works, as in just about every U.S. rolling mill, you'll find Mack-Hemp striped red wabbler rolls helping the operators turn out maximum tonnages between regrinds.

MACKINTOSH-HEMPHILL • Division of E. W. BLISS COMPANY
Pittsburgh and Midland, Pa.

MACKINTOSH-HEMPHILL DIVISION · PITTSBURGH · U.S.A.

BLISS

This man is tabling downtime indefinitely with SKF's new steel pillow blocks

He's cutting bearing maintenance to a minimum yet drastically reducing the chances of table downtime! For he's equipping the mill tables with SKF's new SMT Steel Pillow Blocks with self-aligning spherical roller bearings.

The split construction design of these new pillow blocks makes it possible for rolls to be removed without disturbing base alignment. The non-rubbing, labyrinth-type seal effectively keeps out scale and water and is not affected by high temperatures.

The Type "C" Spherical Roller Bearing gives him the highest capacity available in any self-aligning roller bearing. This high capacity is available despite angular misalignment caused by heat warpage of the table structure or other factors promoting table misalignment.

He'll save with direct, center lubrication, too . . . because a lubricating groove is provided around the circumference of the outer ring of SKF sphericals with equally spaced holes drilled in the ring connecting the groove to the center of the bearing. Grease moves around the groove and through the holes which channel it directly to the center of the bearing.

Why not make the change-over to SKF Steel Pillow Blocks yourself? Write for Catalog #447.

7321

Spherical, Cylindrical, Ball, and "Tyson" *Tapered Roller Bearings*

EVERY TYPE—EVERY USE

SKF®

SKF INDUSTRIES, INC., PHILADELPHIA 32, PA.

* REG. U. S. PAT. OFF.

12 B&W IFB lined single stack annealing covers in use in the strip annealing department of Weirton Steel Company, a division of National Steel Corporation, at Weirton, West Virginia.

uses lightweight B&W Insulating Firebrick for single stack annealing covers.

These 12 covers, lined with B&W K-20 Insulating Firebrick, have been in service more than two years in the annealing of low and high carbon strip from Weirton's 54″ strip mill. Identical in construction, the covers are over 17 feet from base to skew and over 10 feet in diameter. The domes are of 9″ K-20 IFB construction.

The K-20 is one of B&W's *lightweight* Insulating Firebrick. In fact, B&W K-20 IFB are at least a third of a pound lighter than other 2000 F insulating firebrick. This means savings in the overall weight of portable covers. Additional savings in fuel consumption and cycle time are possible because lightweight B&W IFB store and conduct less heat. Heat is kept in the furnace, not in the lining.

This application points out advantages of light weight in insulating firebrick constructions. And B&W makes the *lightest* weight insulating firebrick. Consult your B&W Refractories Representative for information on how you can profit with lightweight B&W IFB.

Bulletin R-2-H available on request.

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THE BABCOCK & WILCOX CO.
REFRACTORIES DIVISION
GENERAL OFFICES: 161 EAST 42nd ST., NEW YORK 17, N.Y.
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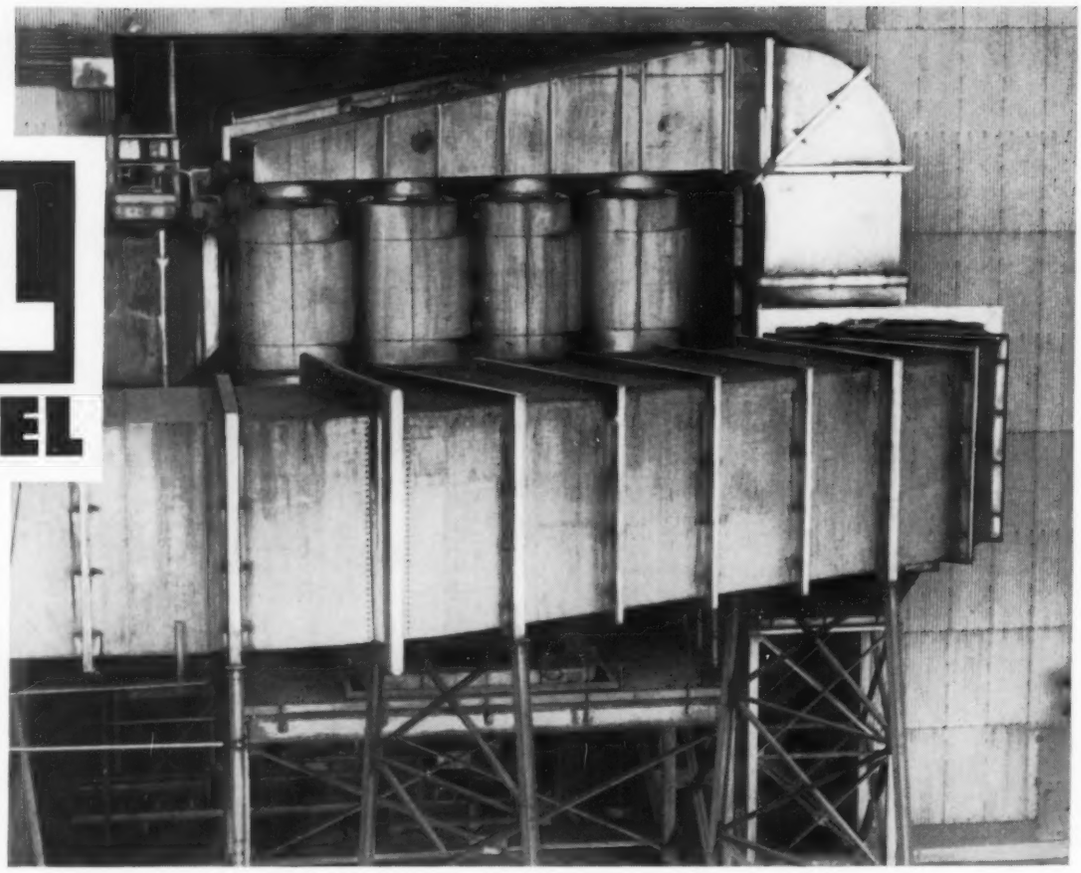
B&W REFRACTORIES PRODUCTS:
B&W Allmul Firebrick • B&W 80 Firebrick • B&W Junior Firebrick • B&W Insulating Firebrick • B&W Refractory Castables, Plastics and Mortars • B&W Silicon Carbide • B&W Ramming Mixes • B&W Kaowool

R-617



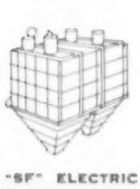
Buell Cyclone System on gas duct exit of sintering machine at Jones & Laughlin, Cleveland.

BUELL High Efficiency Cyclones at Jones & Laughlin

Specially designed for sintering machine operation, these Buell extra-efficient cyclone collectors handle 280,000 CFM of dust-laden gases from sinter bed before entering exhaust fan. Sixteen large-diameter cyclones at exhaust fan and four at the discharge end recover an important *extra percentage* of dust, beyond the abilities of ordinary cyclones, that contributes to the operating efficiency of the machine.

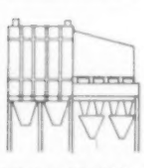
BUELL CYCLONES

Only Buell Cyclones have the "Shave-off", which traps dust rising in the double eddy currents within the cyclone. This uniquely successful feature increases cyclone efficiency, permits large-diameter design which eliminates bridging, clogging, or plugging. Heavy plate construction and ¾" refractory lining provide long service life and minimum maintenance.



"SF" ELECTRIC PRECIPITATORS

Decades of experience in the collection and recovery of industrial dusts back up Buell engineers. An analysis of your plant's dust collection problems may be made without cost or obligation. For a copy of the booklet, "The Exclusive Buell Cyclone", just write Dept. 60-B, Buell Engineering Company, Inc., 123 William Street, New York 38, N. Y.



PRECIPITATOR-CYCLONE COMBINATIONS

buell®

Experts at delivering Extra Efficiency in **DUST COLLECTION SYSTEMS**

Date-line Diary...

January 2

Δ FICA Social Security payments, are now 2½ per cent on the first $4800, and are expected by 1969 to reach 4½ per cent, through four more boosts of one half per cent each.

January 5

Δ The Commerce Dept. reported that manufacturers inventories for November, 1958, on a seasonally adjusted rate, were valued at $49,300,000,000, the same as in September and October, 1958.

Δ Auto production in the U. S. in 1958 declined to 4,244,005 cars, 31 per cent under 1957 output.

Δ Inland Steel Products Co., subsidiary of Inland Steel Co., purchased the tools and machinery used for production of rigid frame metal buildings from Steelcraft Manufacturing Co., Cincinnati, Ohio.

Δ The AISI reports that the operating rate of the steel industry for the week of January 5 is scheduled at 2,109,000 tons (74.5 per cent of January 1, 1959 capacity of 147,633,670 tons). This compares with 2,058,000 tons one week ago (76.2 per cent 1958 capacity of 140,742,570 tons), and 1,515,000 tons one year ago. Index of production for the week is 131.3.

January 6

Δ President Eisenhower told Congress that defense spending in the fiscal year starting July 1, 1959 will be budgeted at $40,900,000,000, $100,000,000 more than indicated expenditures in the present year.

Δ Rail freight loadings in the week ended December 27 amounted to 431,938 cars, up 5.5 per cent over the like 1957 period; for all 1958 rail freight shipments fell to 30,200,000 cars, down 14.9 per cent from 1957 total loadings.

January 7

Δ The AISI reported that the iron and steel industry's payroll for 94.9 per cent of the industry for hourly and salaried employees totaled $306,281,144 during November, 1958, against $326,307,323 in October, 1958. Average hourly payroll cost for wage earners was $3.314, compared with $3.241 in October, 1958 and $3.013 during November, 1957. Fringe benefits amounting to 33¢ per hr are not included. Total employment during November, 1958 totaled 542,464 compared with 540,590 in October, 1958; average hours worked per week in November was 36.5 compared with 39.1 in October, 1958.

January 8

Δ Commerce and Labor Depts. report construction outlays in 1958 climbed to $49,000,000,000, two per cent over 1957, and predict a rise to $52,000,000,000 in 1959.

Δ The Commerce Dept. reported that total inventories as of November 30, 1958 were valued at $85,100,000,000, $200,000,000 over the October 31 valuation.

Δ Securities registered with the SEC for sale to the public for the fiscal year ending June 30 amounted to $16,500,000,000. Recently SEC issued figures showing $17,300,000,000 registered in the 12 months ended December 31, 1958.

Δ Alfried Krupp has purchased the Bochumer Verein with a capital of $23,000,000, which together with the $27,500,000 Rheinhausen steel plant he operates, make him Germany's biggest steel producer.

Δ Inland Steel Co. is filing a registration statement with the SEC for an issue of first mortgage bonds, to be designated Series L to raise $50,000,000 new financing, supplying working capital required for expanded operations and in part to provide for additional capital expenditures.

Δ The Bureau of Mines reported that production of Pennsylvania anthracite for December, 1958 was 2,324,000 net tons compared with 1,585,000 in November, 1958 and 1,826,000 tons in December, 1957. Total for 1958 is 21,856,000 net tons compared with 25,338,000 net tons in 1957.

Δ The Treasury Dept. next week will offer 21-year 4 per cent bonds to raise $750,000,000 in new cash. The Department will also offer $2,500,000,000 of 16-month, 3.25 per cent Treasury notes.

Δ The AISI reports that the operating rate of the steel industry for the week of January 12 is scheduled at 2,123,000 tons (75.0 per cent of capacity). This compares with 2,085,000 tons one week ago (73.6 per cent capacity) and 1,538,000 tons one year ago. Index of production for the week is 132.2.

January 13

Δ Custom smelter copper prices were raised ½¢ to 29½¢ a lb.

Δ The Agricultural Dept. reported that farm price support operations at November 30, 1958 had nearly $8,300,000,000 support by U. S. funds, an increase of $1,100,000,000 over a year ago.

Δ Shipments of iron and steel castings for October, 1958 totaled 1,149,100 short tons compared with 1,058,817 tons in September, 1958 and 1,323,618 tons in October, 1957.

Δ The AISI reports that steel output in December, 1958 amounted to 8,713,000 net tons compared with 8,569,318 tons in November, 1958.

January 14

Δ The Commerce and Labor Depts. reported that unemployment in mid-December, 1958 totaled 4,108,000, 275,000 above mid-November, 1958; total employment totaled 63,973,000 down 680,000 at the same dates.

January 15

Δ Hard coal miners approved a new contract with anthracite mine operators which provides a $20 increase in vacation pay, $1 a day wage boost, and a boost from 50 to 70¢ per ton royalty operators pay to miners welfare fund. The operators agreed to permit union officials to inspect their records on "data related to wages, hours and working conditions."

Δ The Board of Directors, Inland Steel Co., recommended a 3 for 1 capital stock split. The proposal will be submitted at the stockholders meeting to be held April 22, 1959.

January 16

Δ In December, 1958 housing starts zoomed to a seasonally-adjusted rate of 1,430,000 annually, 100,000 over the November pace. Starts for the year 1958 were 1,200,000.

Δ Personal income in December decreased to an annual rate of $359,300,000,000 down $900,000,000 from the November rate; for the year 1958 total was $353,400,000,000 an increase of $5,500,000,000 over 1957.

Δ Effective February 1, prices of hard coal at the mines will be increased from 60¢ to $1 a ton.

Δ The nation's iron and steel companies will spend over $1,000,000,000 for new equipment and construction in 1959 compared with $1,200,000,000 capital expenditures in 1958 according to the AISI.

Δ The Bureau of Mines reported that consumption of scrap during November, 1958 totaled 4,805,000 gross tons, pig iron used was 5,169,000 gross tons. This compared with 5,091,207 tons of scrap and 5,239,582 tons of pig iron in October, 1958.

January 19

Δ New car sales in the first third of January, 1959 averaged 15,500 daily, compared with 21,525 in the final third of December, 1958 and 14,600 in the first third of January, 1958.

Δ The AISI reports that the operating rate of the steel industry for the week of January 19 is scheduled at 2,147,000 tons (75.8 per cent of capacity). This compares with 2,111,000 tons one week ago (74.6 per cent capacity) and 1,496,000 tons one year ago. Index of production for the week is 133.7.

Δ The Aluminum Assn. reported that primary aluminum production in the United States during December, 1958 was 152,301 short tons compared with 140,962 tons in November, 1958 and 140,033 tons in December, 1957. Production for the year 1958 totaled 1,564,341 short tons compared with 1,647,710 tons in 1957.

Δ The ARCI reports that deliveries of new freight cars in December, 1958 totaled 2621 cars compared with 1803 in November, 1958 and 6174 in December, 1957; total deliveries in 1958 were 42,760. New orders for December, 1958 amounted to 3830 compared with 6295 in November, 1958, and 3443 in December, 1957; total orders for the year 1958 were 17,546. Backlog of cars on order as of January 1, 1959 amounted to 27,596 compared with 27,962 on December 1, 1958, and 55,941 on January 1, 1958.

January 20

Δ The National Foreign Trade Council predicted that U. S. exports for 1959 will amount to above $17,000,000,000, compared with 1958 total of $16,200,000,000; imports of $13,800,000,000 in 1959 will surpass 1958 total by nearly $1,000,000,000.

January 21

Δ United States Steel Corp. announced completion of the new sintering plant at the Gary, Ind., steel works. Plant has a daily capacity of 15,000 tons of sinter.

January 22

Δ A. M. Byers increased prices by 3¾ per cent on its electric furnace stainless bars, billets and wire.

Δ Agreement has been reached whereby the Aluminum Company of America will acquire all the properties of Rome Cable for 355,226 shares of Alcoa common stock, permitting distribution to Rome shareholders of three shares of Alcoa common stock on each five shares of Rome common. The agreement is contingent upon approval by Rome shareholders, March 25.

Δ American Metal Climax, Inc. reduced price of lead 1¢ to 12¢ a lb.

Δ Jones & Laughlin Steel Corp. announced stripping and development operations have begun at the Lind-Greenway mine, on the extreme west end of the Mesabi range in Minnesota which will produce high quality beneficiated iron ore. Expected production is about 700,000 gross tons of concentrated ore annually.

Δ The Industrial Heating Equipment Assn. reported that new orders for industrial furnaces in December, 1958 were $4,283,000 compared with $3,992,000 in December, 1957. Orders in the last half of 1958 totaled $26,535,000 compared with $17,798,000 in the first half of the year. New orders for induction heating equipment in December, 1958 totaled $624,000 compared with December, 1957 volume of $519,000. New orders for the last half of 1958 were $3,727,000 compared with $2,915,000 in the first half of the year.

January 23

Δ The American Steel Warehouse Assn. reports that steel buying from warehouses is expected to be 10 per cent higher in the quarter ending March 31, 1959 than in the final quarter of 1958 and 25 per cent higher than the first quarter of 1958.

Δ Rail freight loadings for the week ended January 17 were 586,254 cars, 2.3 per cent above the like 1958 period.

January 26

Δ Blaw-Knox Co. will pay approximately $13,000,000 in cash for Aetna-Standard Engineering Co.'s assets, with certain exceptions, per the proxy statement for a special meeting February 20 of Aetna stochkolders.

Δ The AISI reports that the operating rate of the steel industry for the week of January 26 is scheduled at 2,212,000 tons (78.1 per cent of capacity). This compares with 2,056,000 tons one week ago (72.6 per cent capacity) and 1,459,000 tons one year ago. Index of production for the week is 137.7.

Δ The officers of Pittsburgh Steel Co. and Sharon Steel Corp. have been discussing the possibility of a merger. No agreement has been negotiated; discussions are purely exploratory.

Δ The AISC reports that bookings of fabricated steel in December, 1958 totaled 196,510 tons compared with 242,635 tons in November, 1958 and 140,706 tons in December, 1957. Shipments in December, 1958 totaled 266,600 tons, compared with 271,088 tons in November, 1958 and 320,210 tons in December, 1957. Bookings in 1958 were 2,773,444 tons compared with 3,073,179 tons in 1957; shipments in 1958 totaled 3,664,247 tons compared with 4,179,708 tons in 1957. Backlog of future work as of December 31 totaled 1,808,771 tons.

STEEL COMPANIES FINANCIAL REPORTS—PERIODS ENDING DECEMBER 31, 1958

	Period	1958 Net Sales	1958 Net profit	1958 Earnings per share	1957 Net sales	1957 Net profit	1957 Earnings per share
Acme Steel Co.	4th quar.	.....	.....	....	31,460,614	623,964	0.25
	Year	128,797,000	5,270,000	1.88	148,748,561	6,016,524	2.40
Alan Wood Steel Co.	4th quar.	.....	1,231,000	....	760,500	.....	....
	Year	54,163,000	2,109,000	2.68	67,890,000	2,054,000	2.60
Allegheny Ludlum Steel Corp.	4th quar.	57,364,939	3,317,307	0.86	52,649,348	1,925,899	0.50
	Year	201,715,284	5,844,803	1.52	266,593,541	11,651,851	3.02
Armco Steel Corp.	4th quar.	249,295,320	23,399,972	1.58	250,123,962	12,114,205	0.84
	Year	867,589,722	57,233,314	3.87	1,073,705,249	68,297,928	4.71
Barium Steel Corp.	Year	28,052,000	(1,895,000)	(1.83)	Comparisons not applicable because of spin off of certain subsidiary companies.		
Bethlehem Steel Co.	4th quar.	529,937,086	57,678,360	1.24	601,680,125	47,273,306	1.02
	Year	2,005,937,130	137,741,946	2.91	2,603,713,277	191,025,933	4.13
A. M. Byers Co.	4th quar.	5,461,229	275,200*	0.77*	4,856,544	49,200*	(0.09)*
Carpenter Steel Co.	4th quar.	16,049,439	894,888	0.98	12,356,468	842,830	0.94
Colorado Fuel and Iron Corp.	4th quar.	.....	866,788	0.21	.....	2,036,628	0.56
	Year	.....	2,147,223	0.47	.....	14,236,851	4.04
Copperweld Steel Co.	4th quar.	30,160,963	1,390,224	1.23	28,370,764	622,829	0.54
	Year	93,526,152	2,081,114	1.76	121,094,351	2,769,855	2.41
Detroit Steel Corp.	4th quar.	19,000,000	.....	....	.....	.....	....
	Year	61,000,000	.....	0.25	82,458,616	3,004,382	0.90
Eastern Stainless Steel Corp.	Year	49,300,000	.....	3.50	47,336,093	1,831,952	2.78
Granite City Steel Co.	4th quar.	36,444,000	3,156,000	1.47	29,756,000	2,111,000	0.98
	Year	125,000,000	9,374,000	4.36	123,763,000	9,984,000	4.64
Inland Steel Co.	4th quar.	183,536,377	15,671,302	2.73	181,094,093	15,730,247	2.74
	Year	661,253,596	47,869,042	8.32	772,380,683	58,876,875	10.34
Jones & Laughlin Steel Corp.	4th quar.	191,433,000	10,809,000	1.34	186,740,000	7,482,000	0.91
	Year	654,060,000	23,198,000	2.79	837,568,000	45,452,000	5.65
Kaiser Steel Co.	Year	181,385,288	5,422,271	0.76	208,619,403	21,438,507	5.91
Keystone Steel & Wire Co.	4th quar.	.....	1,844,609	0.99	22,542,857	1,196,804	0.64
	6 mos.	.....	3,367,879	1.80	43,273,992	2,342,059	1.25
McLouth Steel Corp.	Year	.....	9,998,000	5.65	.....	9,410,000	5.37
National Steel Corp.	4th quar.	158,605,702	14,605,793	1.94	147,901,847	11,368,963	1.53
	Year	539,957,294	35,827,414	4.80	640,967,342	45,518,884	6.13
Pittsburgh Steel Co.	4th quar.	40,316,000	959,000	0.40	40,449,000	(120,000)	(0.28)
	Year	133,919,000	(866,000)	(1.37)	182,045,000	4,155,000	1.80
Republic Steel Corp.	4th quar.	.....	22,832,437	1.46	.....	11,975,228	0.77
	Year	910,382,817	61,921,680	3.96	1,227,257,507	85,014,422	5.45
United States Steel Corp.	4th quar.	937,081,509	90,728,989	1.57	1,034,243,514	90,096,731	1.56
	Year	3,472,411,250	301,302,643	5.13	4,413,806,173	419,406,956	7.33
Woodward Iron Co.	4th quar.	.....	918,169	0.44	.....	.....	....
	Year	.....	3,633,334	1.72	.....	3,385,334	1.60
Wheeling Steel Corp.	4th quar.	.....	4,088,000	....	.....	2,971,000	....
	Year	221,008,000	8,899,000	3.69	249,756,000	12,078,000	5.32
Youngstown Sheet and Tube Co.	Year	506,959,574	21,501,320	6.23	688,611,592	42,508,579	12.35

Figures in parentheses are losses.
* After preferred dividends.

January 27

Δ Machine tool orders in December, 1958 totaled $30,100,000 an increase of 35 per cent over November, 1958 and 61 per cent higher than December, 1957.

Δ United Engineering and Foundry Co. report sales in 1958 of $90,563,994, net income $6,909,111 or $2.75 per common share, compared with sales of $100,-456,069, net income of 5,069,960 or $2.02 per share in 1957.

January 28

Δ Bethlehem Steel and Youngstown Sheet & Tube announced that their merger agreements dated December 11, 1956 have been terminated.

Δ Eastern Stainless Steel Corp. directors proposed a two-for-one stock split, a dividend boost and an increase in authorized common stock from 1,000,000 shares of $5 par value stock to 3,000,000 shares of $2.50 par value stock. The charter amendments would be subject to approval of stockholders at a March 31 meeting.

January 29

Δ Custom smelters marked up copper prices ½¢ to 30¢ a lb.

Δ F. W. Dodge Corp. reports that construction contract awards in December, 1958 amounted to $2,281,-881,000. Contract awards for the year 1958 amounted to $35,089,703,000, an increase of 9 per cent over 1957.

Δ Westinghouse Electric Corp. reports for the year 1958 sales amounted to $1,895,699,000, income equalled $74,772,000 equal to $4.25 a common share, compared with 1957 sales of $2,009,043,000, net income $72,652,000 equal to $4.18 a common share.

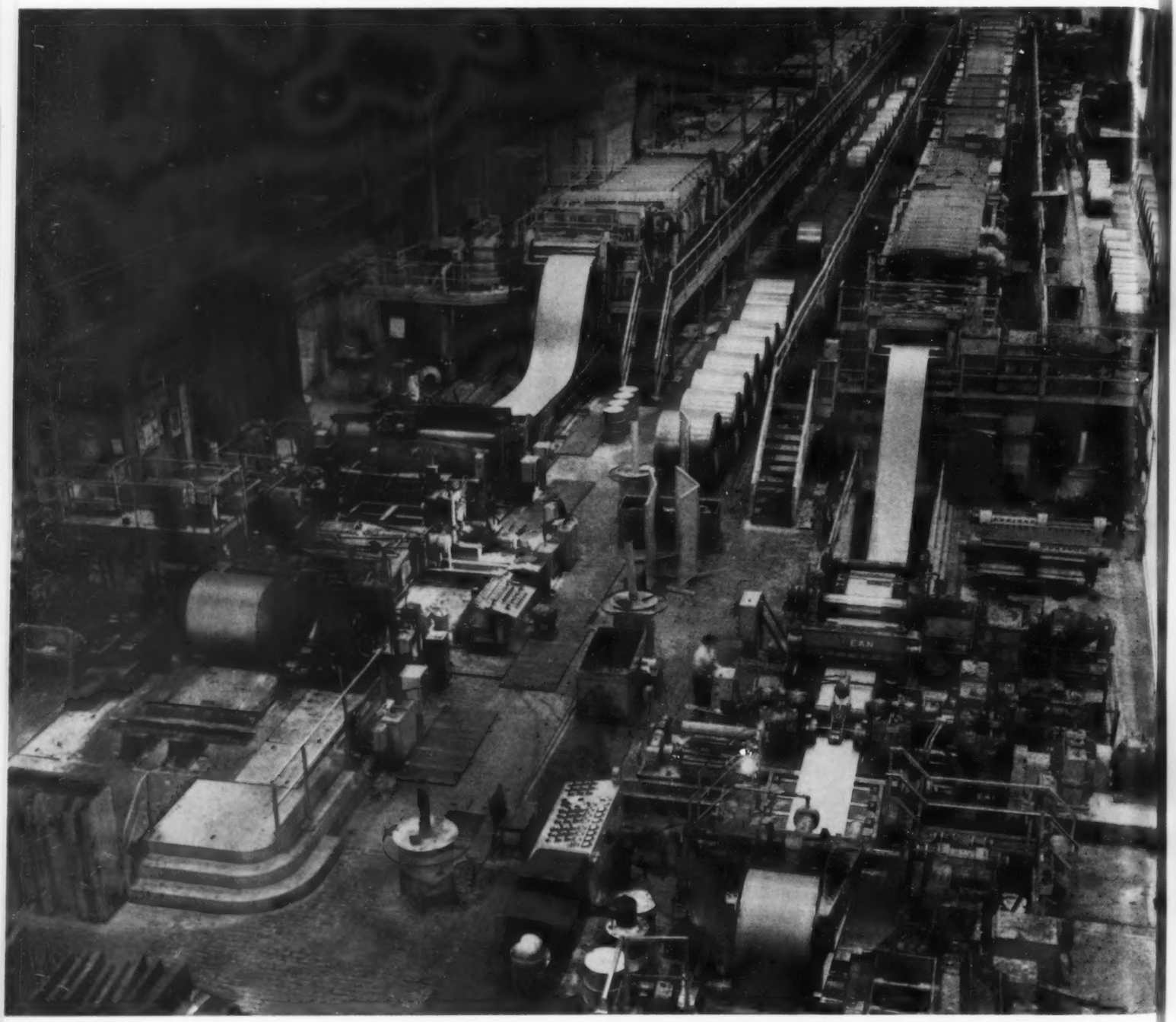
January 30

Δ Shipments of iron and steel castings for November, 1958 totaled 1,106,919 short tons compared with 1,149,100 tons in October, 1958, and 1,135,157 tons in November, 1957.

Δ Firth Sterling, Inc. has acquired all patents, inventories and production facilities of the Kellogg specialty alloy steel manufacturing business in a purchase at an undisclosed consideration from The M. W. Kellogg Co., a subsidiary of Pullman Inc.

At Cleveland Works Division of the Exciting New J&L...

Wean lines give "finishing touch"



Wean 80" and 56" Continuous Strip Pickling Lines.

Quick facts on Wean processing equipment at J&L, Cleveland:

- **80" Continuous Pickling Line:** max. exit coil wt.—60,000#; strip thickness—.060" to .188"; line speeds—1000 FPM (entry end), 375 FPM (tanks and exit end).
- **56" Continuous Pickling Line:** max. exit coil wt.—50,000#; strip thickness—.060" to .250"; line speeds—1200 FPM (entry end), 500 FPM (tanks and exit end).
- **54" Cold Rolled Shear Line:** max. coil wt.—60,000#; strip thickness—.025" to .060"; sheet lengths—30" to 180"; line speed—800 FPM.
- **80" Cold Rolled Shear Line:** max. coil wt.—60,000#; strip width—24" to 72"; strip thickness—.012" to .0937"; sheet lengths—30" to 192"; line speed—300 FPM.
- **80" Hot Rolled Up-Cut Shear Line:** max. coil wt.—30,000#; strip width—24" to 75"; strip thickness—.375"; sheet lengths—48" to 500"; line speed—140 FPM.
- **80" Hot Rolled Flying Shear Line:** max. coil wt.—30,000#; strip width—18" to 75", thickness—.048" to .250"; sheet lengths—24" to 288"; line speed—350 FPM.

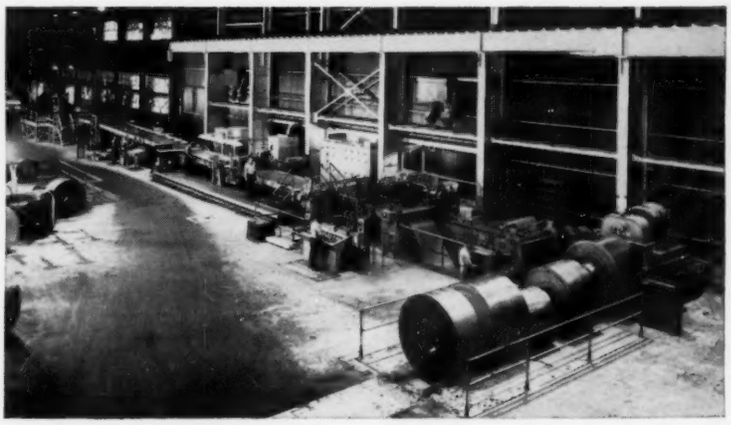
to high-quality J&L Steel

At these Jones & Laughlin facilities, Wean processing equipment plays an important role in the production of highest quality strip and sheet.

The 56″ and 80″ Wean continuous pickling lines efficiently remove scale from the strip prior to cold reduction. Four Wean shearing lines provide versatile combinations of shearing, recoiling, slitting, edge trimming and temper passing to produce sheet in a wide range of sizes and in thicknesses from .012″ to .375″ to suit every customer requirement.

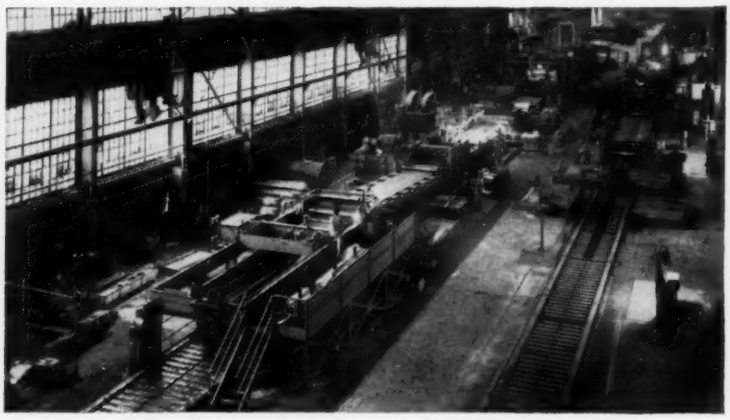
The dependable, economical performance of these Wean installations typifies the advantages you can expect from Wean *creative engineering*—whatever your requirements for continuous steel processing lines.

Wean 80″ Cold Rolled Strip Shear Line.



Wean 54″ Cold Rolled Strip Shear Line.

Two Wean 80″ Hot Rolled Strip Shearing Lines with McKay Processing Uncoilers.



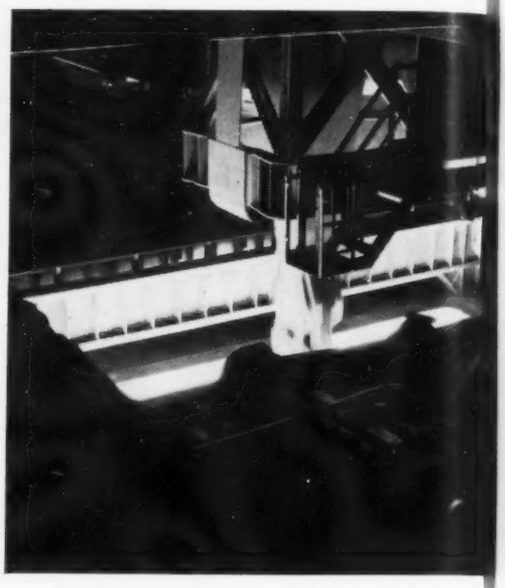
Exit End—Wean 80″ Hot Rolled Shearing Lines (Flying Shear—left; Up-Cut Shear—right).

Specialists in the design and construction of sheet, strip and tin plate processing lines . . .

THE WEAN ENGINEERING COMPANY, INC. • WARREN, OHIO

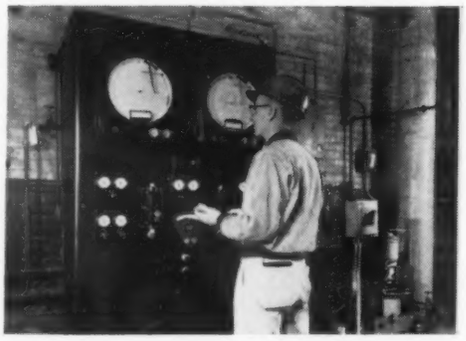
General view of three slab re-heating furnaces with Hagan combustion and gas pressure controls. Control cubicles are visible to the right. Installed over 10 years ago, these systems are operating with the same high efficiency as the day they were started up.

Row #12, consisting of a new four-hole battery of soaking pits, has Hagan controls and meters on fuel-air ratio, pit pressure and gas pressure. Maintenance on these systems has been extremely low, and since they are pneumatic, they make possible the good housekeeping that is a vital part of plant safety practices. Precise control assures optimum scale formation and an absence of ingot washing.



at the exciting new J&L... from steel to ingots to slabs...

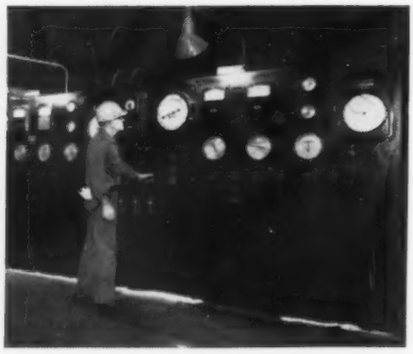
Panel for the pH control on the recirculating cooling water system. The Hagan Ring Balance meters shown here are among the more than 50 Hagan meters that are measuring both produced and natural gas, steam, water, air and oxygen flow in various parts of the plant.



HAGAN CONTROLS help maintain high quality

Hagan has kept pace with the plant modernization program at J&L's Cleveland Works, with the installation of many new Hagan control systems. For example, Hagan combustion and gas pressure controls are an important part of three rebuilt open hearth furnaces. From open hearth to re-heat furnaces, Hagan instrumentation and control help maintain production and quality. These pictures show only a few of the many areas where Hagan controls are at work.

Control panel for the new pits. These are the latest of the 16 pits at Cleveland Works with Hagan controls. The panel is designed for good visibility and ease of operation.



Control panel for soaking pits #5 & 6. These systems include fuel/air ratio and pit pressure controls. Installed in 1936, they are still functioning efficiently, with minimum attention.

HAGAN CHEMICALS & CONTROLS, INC.

DIVISIONS: CALGON COMPANY, HALL LABORATORIES

HAGAN BUILDING, PITTSBURGH 30, PA.
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WHEN part of your working capital is needlessly tied up in inventory–it is comparable to deep-freezing a bundle of cash and putting it out of circulation. Obviously, such frozen assets can't work, won't produce profit. That's why so many bearing users, both large and small, use Berry's inventory as *their* inventory...cut their own inventory to the minimum...and...employ the money realized for more profitable purposes.

Actually, there is no need to maintain a large bearing inventory of your own--when you can get **immediate delivery** on *anything*...and...*everything* you need from Berry Bearing Company. With over 50,000 different types and sizes of bearings, bearing specialties, and transmission appliances regularly in stock Berry can supply you with exactly what you want--when you want it. For convincing proof--why not phone bearing headquarters--**NOW.**

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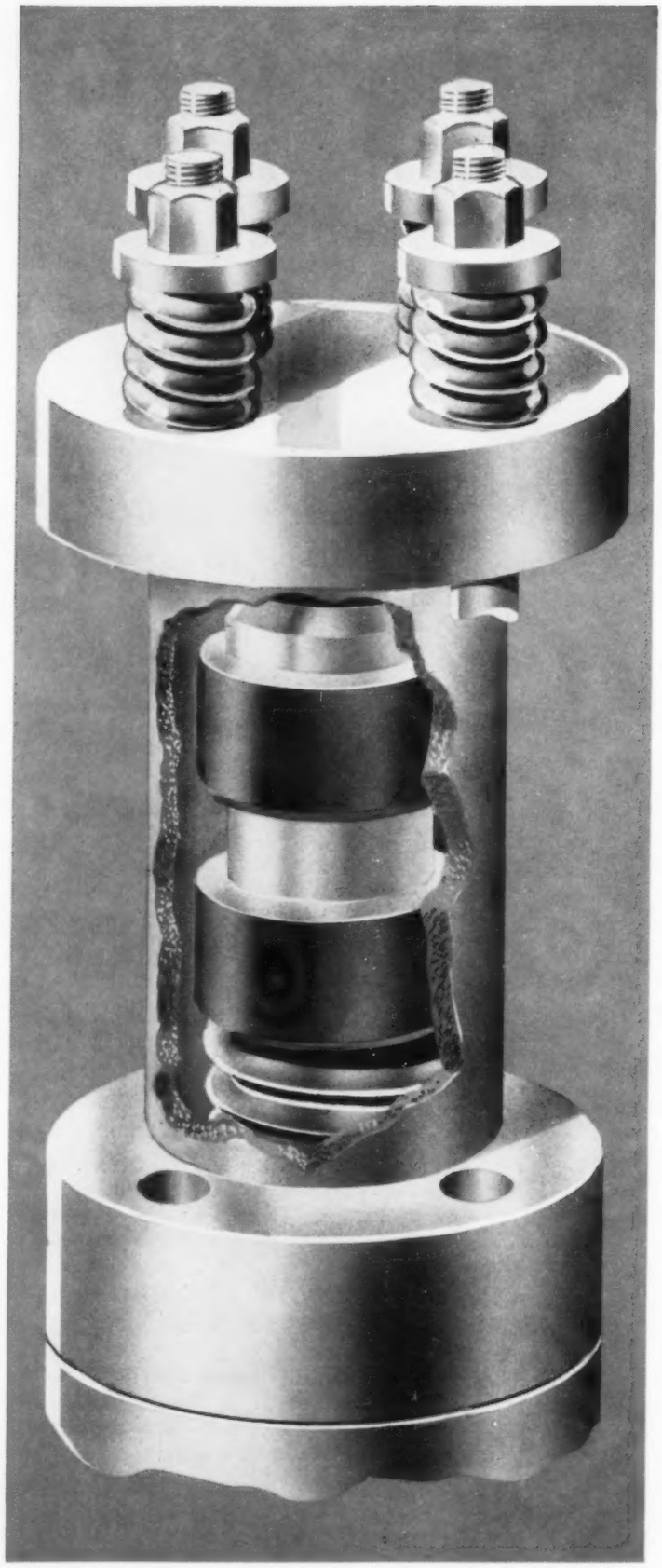
by bringing you lower precipitator maintenance and operating costs with

K-30*

bonded pistons on pneumatic vibrators



By eliminating the need for lubrication of the rapping mechanism in electrostatic precipitators, Koppers saves you many operational man-hours and maintenance costs.

This lubrication-free operation results from bonding a new wear-resistant material to vibrator piston surfaces. This special self-lubricating compound, identified by Koppers as "K-30," is composed of Teflon† and other wear-resistant materials that together provide a self-lubricated surface.

Most rapping mechanisms demand regular maintenance to be trouble-free, but "K-30" eliminates this need and provides more reliable operation.

Koppers research, backed by many years of experience in the electrostatic precipitation field will help you find the answer to your gas cleaning problems. Check with Koppers to learn how "K-30" can develop top efficiency in present or planned precipitator installations. For more information, write: KOPPERS COMPANY, INC., 6802 Scott Street, Baltimore 3, Maryland.

*Koppers Trademark

†E. I. duPont de Nemours & Company, Inc. trademark for tetrafluoroethylene resin

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ELECTROSTATIC PRECIPITATORS

Engineered Products Sold with *Service*

Industry News...

WHEELING STEEL COMPLETES AGREEMENT TO PURCHASE FOLLANSBEE STRIP-SHEET MILLS

△ Wheeling Steel Corp. has concluded the purchase agreement for the strip and sheet mills of Follansbee Steel Corp. in Follansbee, W. Va. In a joint announcement, William A. Steele, president of Wheeling Steel, and Louis Berkman, president of Follansbee Steel, reported the completion of the transaction and indicated that the transitional period would be worked out within the next few months.

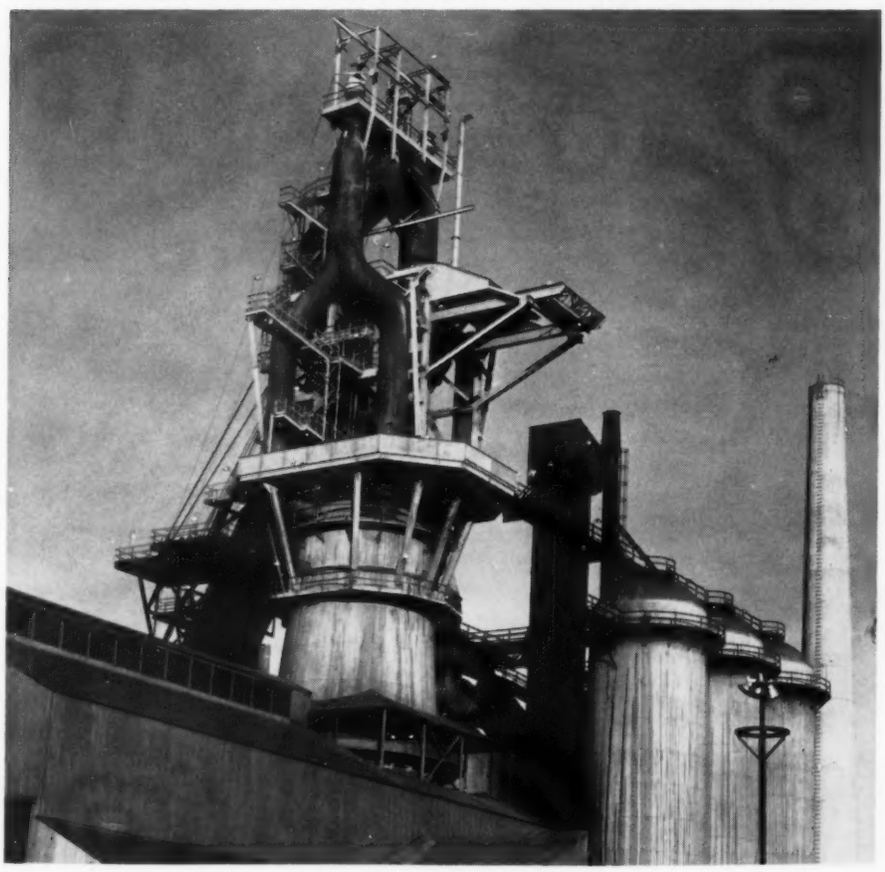
Follansbee Steel, however, will continue to produce and distribute its terne roofing products, blue steel and other products. Those facilities will continue to be owned and operated by the present management of Follansbee Steel.

The plant area to be acquired by Wheeling Steel comprises about fifty acres in Brooke County. The strip and sheet mills have rated annual capacities of 150,000 net tons of cold rolled strip and 100,000 net tons of cold rolled sheets.

The Follansbee facilities will be operated as a unit of the Steubenville Works. The Steubenville General Works is Wheeling's steel producing plant. Its operations are located in Steubenville and Mingo Junction, Ohio, with the coke-producing operation in Follansbee, adjacent to the mills involved in the transaction.

KAISER BLOWS IN FOURTH BLAST FURNACE

The largest blast furnace on the West Coast has been put into operation at Kaiser Steel Corp.'s Fontana, Calif., plant. The fourth at the plant, the new furnace is designed to produce approximately 1750 tons of molten pig iron per day. This increases Kaiser Steel's annual pig iron capacity from 1,314,000 to 1,912,000 tons. The furnace, standing 232 ft tall, is a key facility in the company's $214,000,000 expansion program now nearing completion. Its output will be required for the plant's new steelmaking facilities. To provide increased tonnages of coke, two new batteries of 45 coke ovens each will be put into operation in the near future, bringing the total number of ovens in production at Fontana to 315 and increase coke producing capacity from 1,005,000 tons to 1,502,000 tons per year. The ovens are Koppers-Beckers by-product ovens, equipped with screw type tension latches, insuring a tight, virtually leak-proof seal when the oven is in operation.



AISI REPORTS OUTPUT AND CAPACITY FIGURES

△ According to the American Iron and Steel Institute U. S. steelmaking furnaces produced 85,254,885 net tons of ingots and steel for castings during 1958. Blast furnace production totaled 57,764,100 net tons of pig iron and ferroalloys.

December steel output, totaling 8,713,000 net tons, was the second highest of 1958, exceeded only by the 8.8 million tons produced in October. The November figure was 8,569,318 tons. The December blast furnace total was 6,072,890 net tons, highest monthly output since October, 1957.

The fourth quarter production, 26,122,096 tons, exceeded the total for any other quarter in 1958 and was above the output of the fourth quarter of 1957 (25,010,921 tons).

During the second half of 1958, steelmaking furnaces poured 47,504,876 tons of raw steel, compared with 37,752,487 tons in the first half of the year and 52,131,449 tons in the second half of 1957.

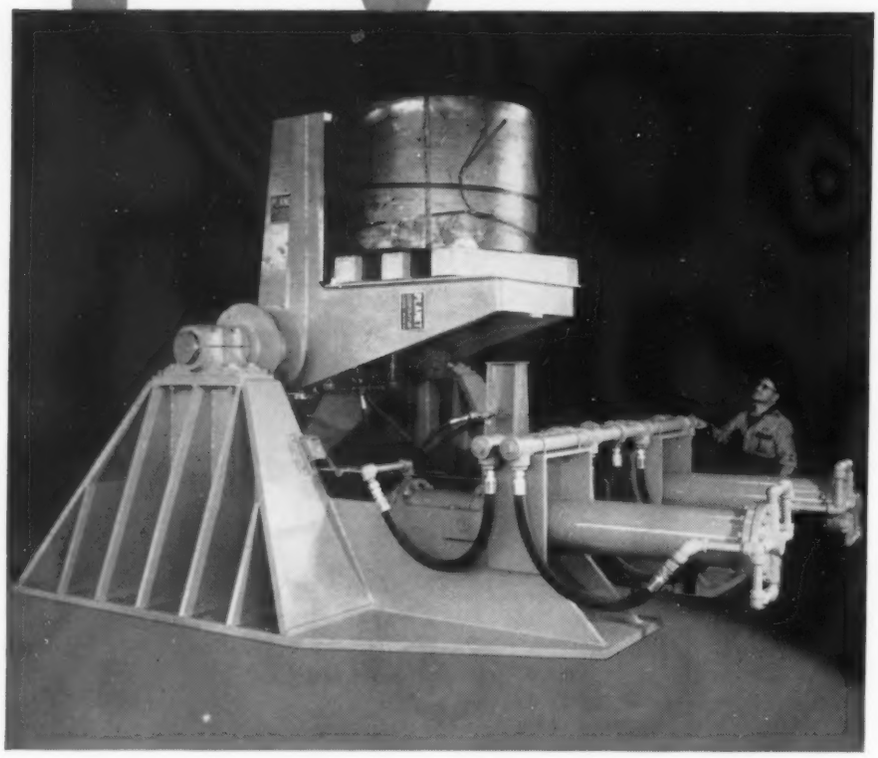
According to the Institute's index of steelmaking, the December output was 122.5 in terms of the basic index of average production during the period 1947–49. This compared with 124.5 during November, 1958, and 104.3 in December, 1957.

For the year 1958, the index was 101.8, against 134.6 during 1957.

For fourth quarter of 1958, the index was 123.7, against 101.3 in the preceding quarter and 118.5 in fourth quarter of 1957.

For the second half of 1958, the index was 112.5, against 90.9 in first half of the year and 123.5 in the second half of 1957.

PV
PLANET VERSATILITY...



HEAVY DUTY UPENDER
TURNS 50,000 LB. STEEL COIL

Planet Corporation's Upender is another example of why Planet is known throughout industry as a versatile organization . . . and as an organization which manufactures quality equipment. Planet's Upender turns 50,000 pound coils from a horizontal position to vertical, or vice versa, and it is made to take day in, day out abuse. Although upenders are not unique (as is most of Planet's equipment) it is evidence of Planet's competence in creating and building even the heaviest of materials handling equipment.

PLAN WITH PLANET If your plant has a production, materials handling, or automation problem, let Planet demonstrate how its versatile engineering skill, and production and erection know-how can help you. It has paid many leading industrial concerns whose names are household words to "Plan with Planet" . . . *it will pay you too to use Planet Versatility.* Write or phone today!

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92

Based on the January 1, 1958, capacity rating of 140,742,570 net tons of steel annually, the steelmaking facilities were utilized at an average of 72.9 per cent of capacity during December, 73.6 per cent in fourth quarter, 67.0 per cent in the second half of 1958, and 60.6 per cent for the entire year.

Steelmaking capacity increased nearly seven million net tons in the past year—to a record 147,633,670 tons annually, as of January 1, 1959.

The new 147.6-million ton figure (the annual capacity for the output of ingots and steel for castings) is 61 per cent higher than the potential at the end of World War II, and is over 30 million tons above the steel industry's greatest annual production, totaling 117 million tons during 1955.

A substantial amount of the increase during 1958 was attributable to the installation of new oxygen furnaces in several steelmaking plants. The annual capacity of oxygen furnaces is now 4,033,160 tons, compared with 1,081,000 net tons at the start of 1958.

However, open hearth furnace capacity increased 4.2 million tons. These furnaces account for over 85 per cent of the total annual steel capacity figure. The combined capacity of open hearths is 126.5 million net tons per year, against 122.3 million tons one year ago.

The capacity of electric furnaces is now about 13.5 million tons, against 13.3 million tons at the beginning of last year. Bessemer steelmaking capacity is nearly 3.6 million tons, against 4.0 million tons a year earlier.

Blast furnace capacity has been increased to a record high level, 94,634,850 net tons annually. This is an increase of 3.6 million net tons during the past year. The industry's coke oven capacity is now rated at 73,098,310 net tons a year, against 72.2 million tons a year earlier.

INLAND STEEL AWARDS CONTRACT TO MESTA

△ The Mesta Machine Co. has been awarded contracts covering the design and manufacture of steel strip coiling and handling facilities for the 44-in. hot strip mill at the Indiana Harbor Works of Inland Steel Co.

Designed to replace existing facil-

ities, the new equipment will provide fully automatic sequenced coiling, stripping, coil tilting and coil transfer operations. The contracts include three rotating-mandrel type hot strip downcoilers; a carry-over table section and deflecting pinch roll stand at each downcoiler; and three motor-driven coil tilters, each with a coil transfer car to shift the coils to the conveyor. The downcoilers feature the use of only two coiling rollers with guides to wrap the strip about the collapsible mandrel. These coilers will have the advantage of reduced maintenance over the multi-roller type, and will produce a more uniform coil.

Mesta will also furnish 145 ft of new coil conveyor of the flat pallet, two and three strand roller chain type to serve the downcoilers. A coil lift will be incorporated to lift coils from the conveyor for weighing. A recirculating oil lubrication system will be provided for the mandrel drives as well as time clock controlled grease lubricating equipment for the downcoilers, pinch rolls, tables, tilters, and transfers. In addition, the contract includes a complete complement of spare parts for the downcoilers and conveyor.

CARNEGIE TECH OFFERS GRADUATE COURSES

△ Carnegie Institute of Technology announces graduate study and research, teaching assistantships, research assistantships and fellowships in the College of Engineering and Science offering opportunities for advanced study and research leading to the degrees of Master of Science and Doctor of Philosophy in the following fields: chemical engineering, chemistry, civil engineering, electrical engineering, mathematics, mechanical engineering, metallurgical engineering, physics; and degree of Master of Science only in nuclear science.

Requirements for advanced degrees, graduate courses and opportunities in research are described in the Bulletin of Graduate Study in Engineering and Science. The bulletin will be sent on request. Applications for admission, etc., should be submitted as early as possible.

Address all inquiries to: Dean of Graduate Studies, Carnegie Institute of Technology, Pittsburgh 13, Pa.

ALCOA AND ROME CABLE MERGER IS PLANNED

△ Rome Cable Corp. and Aluminum Co. of America have announced plans to affiliate.

Frank L. Magee, president of Alcoa, and A. D. Ross Fraser, president of Rome Cable, announced that agreement has been reached on a plan by which Alcoa will acquire all the properties of Rome Cable for 355,226 shares of Alcoa common stock. This will permit distribution to Rome shareholders of three shares of Alcoa common stock on each five shares of Rome common stock. The agreement is contingent upon approval of Rome shareholders, who will meet on March 25. If approved, it will take effect immediately.

Alcoa and Rome plan to combine their electrical conductor, conduit and accessory activities in a new company to be called Rome Cable Co. The present members of Rome's management will continue in their present capacities in the newly formed company. H. T. Dyett will retire, as chairman of the board

How to cut mill downtime due to bearing failures...

use A·B·K* bearings

Roll neck and slipper bearings made of A-B-K material often outwear metal bearings many times. Their ability to cushion impact loads without peening, scoring or heat-checking protects roller necks, housings and chucks. Simplicity of design and light weight speed installation. Can be lubricated with grease, oil or water *alone*. Ask our engineers to help you solve your specific problems.

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- Won't score or heat check
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AMERICAN Brake Shoe COMPANY
AMERICAN BRAKEBLOK DIVISION
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"A drop in the bucket!" The constructions shown here by Tom Weichel, Okonite's portable cable engineer, are just a random sampling of the flexible cords and cables that Okonite has developed for industrial operations. More than likely, Okonite has available right now the exact cable you need—in terms of toughness, flexibility, capacity, resistance to oils, acids, alkalies, water, heat and abrasion. If not . . . we know how to build it!

Here's how we add value to your portable cable dollar

Behind these cable constructions are service records that prove the extra long life of Okocord flexible cords and portable cables under the most severe industrial conditions of mechanical abuse, run-overs, heat, oil, moisture, and constant dragging over cement floors.

Longer cable life means lower operating costs . . . reduction of costly work stoppages . . . greater utilization of expensive equipment. Truly, Okocord's longer life represents money in the pocket for any plant operator.

Here's how Okonite assures maximum value for your cable dollar.

1. By the use of materials developed in 80 years of making the finest cables.
2. By constant research to find even better materials and constructions.
3. By intimate, first-hand knowledge of industrial problems and conditions.
4. By self-imposed standards for manufacturing and testing that are more exacting than the industry requires.

There are Okocord quality cables for your machinery and portable equipment. There are Okonite specialists ready and willing to help you in the planning or installation stages. And there is a brand new booklet full of valuable hints on picking the right cable constructions for your all-important power or control circuits. Write for free Bulletin IS- 1117—"How to choose insulated cable"—to The Okonite Company, Passaic, New Jersey.

where there's electrical power . . . there's **OKONITE CABLE**

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another advantage of
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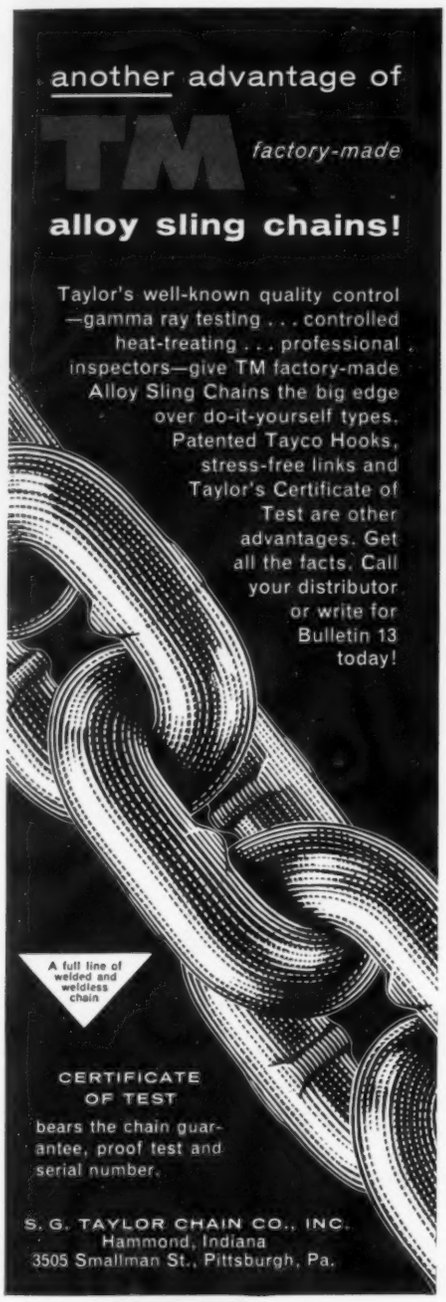

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Hammond, Indiana
3505 Smallman St., Pittsburgh, Pa.

Taylor Made CHAIN SINCE 1873

of Rome Cable, when and if the agreement is consummated, rather than at the annual meeting in June, as previously planned; but he will continue to serve on the board of directors of the new company. Alcoa plans to continue the fundamental policies established by the Rome management.

Rome Cable Corp. has manufacturing plants at Rome, N. Y.; Torrance, Calif.; and Collegeville, Pa., as well as sales offices in principal cities of the United States.

Rome is best known for its broad line of quality insulated wire and cable products—chiefly made of copper—and for its steel conduit and other wiring systems.

NEW WAUKEGAN BRANCH ANNOUNCED BY BERRY

△ Berry Bearing Co. has opened a new, stock-carrying branch in Waukegan, Ill.

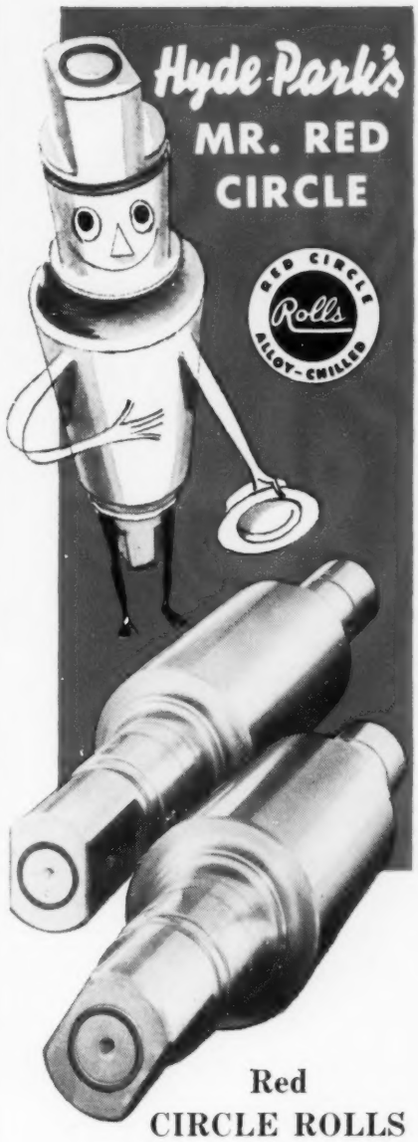
H. D. Sandy, Tom Armstrong, Frank Braun, Charles Bradfield, and Ken Kurth will staff the new branch.

CONNERS WILL EXPAND BIRMINGHAM FACILITIES

△ Connors Steel Division, H. K. Porter Co., Inc., will start construction of new steelmaking facilities at its Connors Works in Birmingham, Ala., it was announced by B. C. Blake, Division Vice President and General Manager.

The modernization will cost approximately a half-million dollars and increase annual ingot tons output by approximately 25 per cent. The expansion includes construction of a pouring building, adjacent to the furnace department, with a 25-ton crane and the installation of pouring car equipment. These new facilities will allow operation of all three of Connors electric furnaces simultaneously instead of the former procedure of two melting and the third as a spare. Target date for completion of the project is early May.

This is the second mill expansion in three years for Connors. The $2,500,000 modernization completed in late 1956 netted the Connors Works an increase in annual ingot tons of approximately 24 per cent. The construction of a cold drawn bar mill made Connors the only producer of this product in the South.



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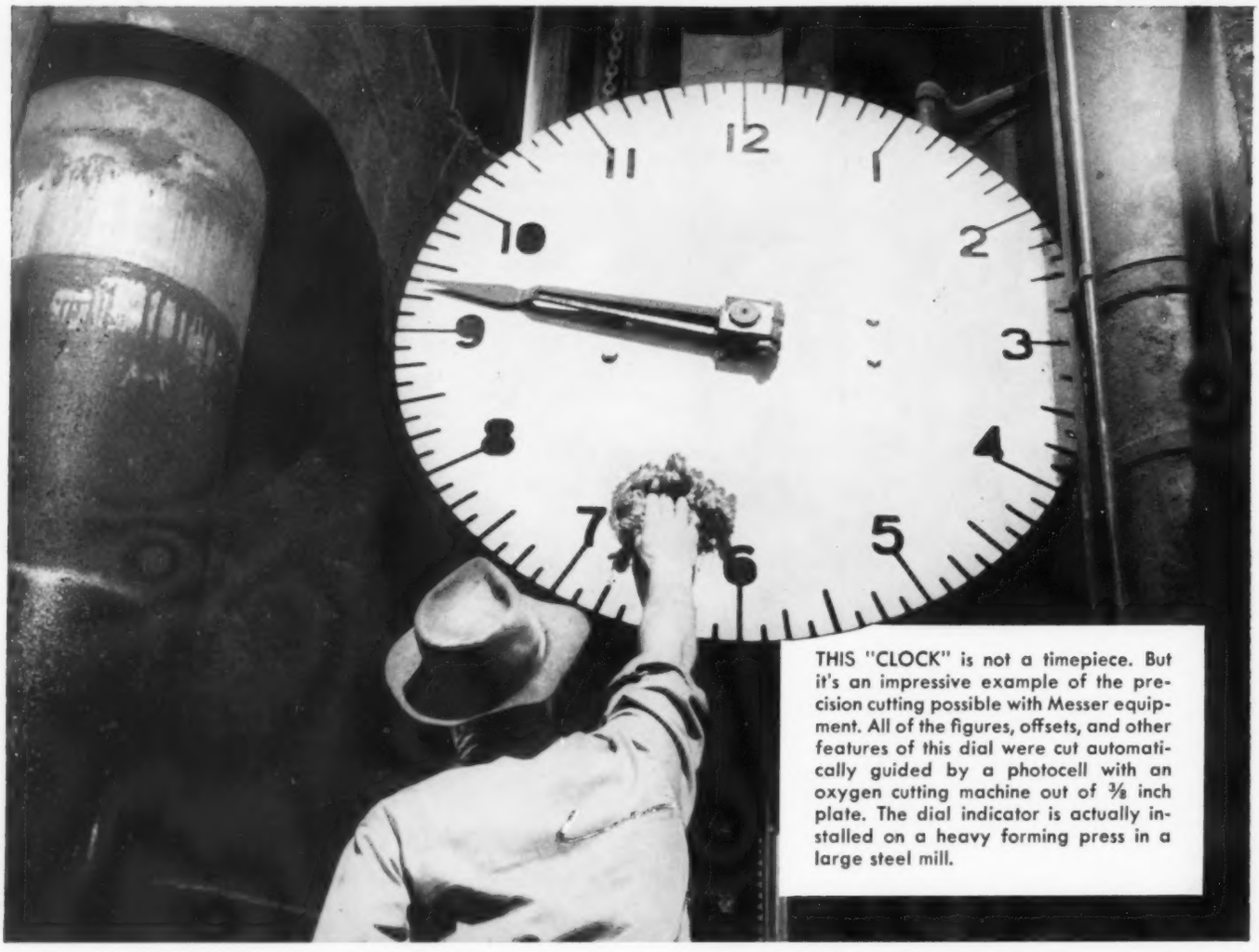

THIS "CLOCK" is not a timepiece. But it's an impressive example of the precision cutting possible with Messer equipment. All of the figures, offsets, and other features of this dial were cut automatically guided by a photocell with an oxygen cutting machine out of ⅜ inch plate. The dial indicator is actually installed on a heavy forming press in a large steel mill.

Around the clock...

MESSER CUTTING MACHINES PERFORM NEW MIRACLES IN AUTOMATIC PRECISION CUTTING

Isn't it "time" you thought about the money-saving advantages you can get through the use of the new and revolutionary cutting techniques now possible with *Messer Cutting Machines?*

INCREASE YOUR PROFITS

Experience has shown that the Messer cutting machine versatility of design permits greater shop flexibility and the increased use of automation. The result? Lower costs, lower waste, GREATER PROFITS.

This unique oxygen cutting equipment features a completely engineered system of operation. This leads to new high standards in precision workmanship and greater accuracy.

ASK US FOR MORE DETAILS!

In steel mills, in shipyards—wherever cutting machines are used—Messer equipment can increase efficiency. It will pay you to find out *now* what Messer can offer you. Write us for full information. No obligation, of course. Messer Cutting Machines, Inc., Chrysler Building, 405 Lexington Avenue, New York 17, N.Y.

Messer Cutting Machines

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42-inch, 3-stand tandem cold reduction mill.

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Blaw-Knox designs and builds all types of cold reduction and temper pass mills for ferrous and non-ferrous work. Other Blaw-Knox equipment for the metals industry includes complete rolling mill installations including all auxiliary equipment for ferrous and non-ferrous metals, iron, alloy iron and steel rolls, Blaw-Knox Medart cold finishing equipment, carbon and alloy steel castings, fabricated steel plate or cast-weld design weldments, steel plant equipment, and heat and corrosion resisting alloy castings.

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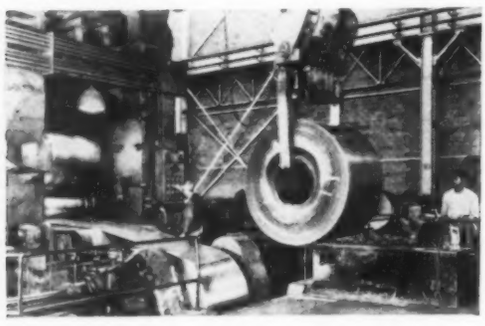
Mansavers are engineered to handle bars, billets, slabs, rods, tubes, coils, sheets, etc., in manual, semi-automatic, fully-automatic, and power-operated styles.



The selection of the proper Mansaver Grab at the time you purchase a crane will appreciably reduce the cost of your entire installation. The proper grab will give you more storage in a given cubic space, reduce aisle widths, and get materials to and from storage and production lines quickly, safely, and with minimum effort.

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☐ COILS

☐ BARS

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Also Manufactured in England

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LONGER VALVE LIFE..

..TIGHTER CLOSURE...

...LESS MAINTENANCE...

ON BLAST FURNACE GAS LINES THAN YOU'VE HAD FROM

ANY OTHER VALVE!

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In fact, DeZurik Valves require an absolute minimum of *any* maintenance. They last longer because there's no friction between plug and body—no binding, no scoring, no seizing! Just easier operation—tighter closure—longer life—less maintenance than you've ever had. Ask the DeZurik representative in your area—or write to us—for more details.

DeZURIK CORPORATION

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FEBRUARY, 1959

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. . . any of the bulletins reviewed in the Publication Service of the IRON AND STEEL ENGINEER without obligation or cost. Simply circle the desired item numbers on one of the prepaid postal cards and mail. The requests will be forwarded to the manufacturers involved who will send the bulletins to you.

Note: Post cards expire three months after publication date.

(1) A-C Magnetic Starters

A comprehensive booklet describing their a-c magnetic starters has been published by Cutler-Hammer, Inc. Description of the individual starters includes general information on each, as well as ratings and dimensions. Also described is the line's component units and elements covering such items as magnet coils, overload relays, contact assembly, enclosure types and others. (EN-150)

(2) Turbine Generators

Westinghouse Electric Corp. has published a 40-page booklet describing their turbine generators from 5000 kw up to 100,000 kw for industrial and electric utility applications. The booklet is divided into two main sections. In the turbine section, standard features as well as special features are described and illustrated. This section is arranged for easy reference relating to condensing and non-condensing turbines, blading, shrink fitted disks, steam chest, steam seals, nozzles, bearings and rotors. A complete description is given, with diagrams, of the hydraulic governing system. This is followed by the many generator features using air and hydrogen cooling. (Booklet B-7373)

(3) Needle Thrust Bearings

The Torrington Co. has issued a catalog discussing their needle thrust bearings with increased capacity ratings. The catalog covers installation, lubrication and load capacity of the needle thrust bearings and design and installation of the thrust races for use with these bearings. It lists the complete line of Torrington needle thrust bearings available in bore sizes from 3/8 in. to 3 in. In addition, the catalog has an expanded list of thrust races for use with these bearings. (Catalog No. 759)

(4) Thrifty Crane Catalog

A new crane which provides big-crane performance at a price substantially lower than the big-crane bracket is described in a bulletin offered by Whiting Corp. The bulletin contains full details on the complete list of crane features. Construction details, capacities, and recommended applications are also given. (Bulletin No. 91)

(5) Modernization

Allis-Chalmers Manufacturing Co. has published a catalog entitled, "59 Ideas for Modernization in '59." This comprehensive booklet points out the many ways that companies are finding to modernize or update their operations. Profusely illustrated, the catalog discusses modernizing ideas for ball mills, circuit breakers, lift trucks, transformers, motors, induction heaters and many others.

(6) Industrial Truck Attachments

A complete line of attachments for powered industrial trucks is discussed in a folder published by the Elwell-Parker Electric Co. The folder illustrates and describes 30 different attachments, designed for greater truck flexibility and versatility, to cut handling costs.

(7) Floodlight Catalog

Crouse-Hinds Co. has recently published a floodlight catalog, designed for easy selection of the proper floodlight for the job. New listings and prices on the company's complete floodlight line are included in this catalog, together with sections on How to Select Floodlights, Mercury Vapor Floodlights, Hazardous Area Lighting and Floodlight Poles. (Catalog 320)

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* INQUIRIES FOR ITEMS LISTED IN THIS ISSUE NOT VALID AFTER MAY 1, 1959

PUBLICATIONS CURRENTLY OFFERED by Iron and Steel Engineer Advertisers

ITEM	COMPANY	BULLETIN	DESCRIPTION
50	AJAX FLEXIBLE COUPLING CO. INC.	CATALOG NO. 64	Spindle couplings
51	AMERICAN BRIDGE DIV., UNITED STATES STEEL CORP.		Heroult electric furnaces
52	AUTOMATIC TRANSPORTATION CO.		Heavy-duty equipment
53	BABCOCK & WILCOX CO., THE	BULLETIN R-2-H	Insulating firebrick
54	BUELL ENGINEERING CO., INC.		Dust collection systems
55	BUSSMANN MFG. DIV., McGRAW-EDISON CO.	BULLETIN FIS	Fuses
56	CUNNINGHAM CO., M. E.		Remote-control marking
57	CUTLER-HAMMER, INC.	BULLETIN 14951-C-232	Master switches
58	DURALOY CO., THE	BULLETIN NO. 3150-G	High-alloy castings
59	ELECTRIC CONTROLLER & MFG. CO., THE DIV. OF THE SQUARE D CO.	BULLETIN 8130	Fuseless air-break starter
60	ELECTRIC CONTROLLER & MFG. CO., THE DIV. OF THE SQUARE D CO.	BULLETIN 6100	D-c crane controls
61	ELWELL-PARKER ELECTRIC CO., THE		Fork and ram trucks
62	EUCLID ELECTRIC & MFG. CO., THE	BULLETINS 2210, 2220 & 2230	Speed-responsive switches
63	FARVAL CORP., THE	BULLETIN 26-S	Automatic lubrication
64	GENERAL ELECTRIC CO.	BULLETIN GEA-6858	Punched steel grid resistors
65	HAUCK MANUFACTURING CO.	DATA SHEET NO. GB 4191A	Gas burners
66	HILL ACME CO., THE CLEVELAND KNIFE DIV.		Metal shearing aids
67	JEFFREY MANUFACTURING CO., THE	CATALOG 910	Magnetic separators and vibrating feeders
68	JOHNS-MANVILLE CORP.	BROCHURE IN-115A	Refractories
69	LARCO, INC.	BULLETIN AC-573	Crane cab and air conditioners
70	LECTROMELT FURNACE DIV., McGRAW-EDISON CO.	CATALOG 10	Lectromelt furnaces
71	MARLAND ONE-WAY CLUTCH CO.	MANUAL NO. 56	Safety backstops
72	MATTHEWS & CO., JAS. H.		Industrial printing equipment
73	OKONITE CO., THE	BULLETIN IS-1117	Insulated cables
74	RAMTITE CO., THE		Steel plant furnace construction
75	ROCKBESTOS PRODUCTS CORP.	PNR 1-58	Control cable conduit fill chart
76	ROCKWELL CO., W. S.	BULLETIN 501	Slide valves
77	SELAS CORP. OF AMERICA	BULLETIN NO. 42	Gradiation heating in the steel mill
78	SKF INDUSTRIES, INC.	CATALOG 447	Steel pillow blocks
79	SPRAYING SYSTEMS CO.	CATALOG 24	Spray nozzles and steel mill applications
80	TAYLOR CHAIN CO., INC., S. G.	BULLETIN 13	Alloy sling chains
81	TEXAS CO., THE		Organized lubrication
82	UNITED STATES STEEL CORP. INDUSTRIAL CARS		Custom designed cars
83	WAGNER ELECTRIC CORP.	BULLETIN MU-223	Motors
84	WALDRON CORP., JOHN	CATALOG 57	Couplings
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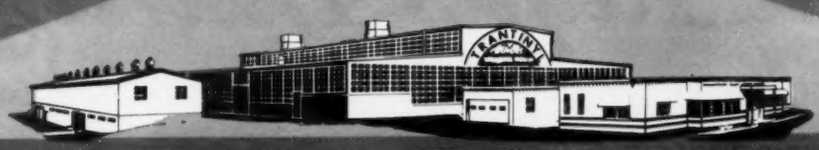

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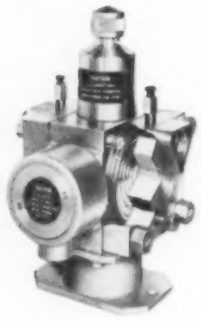
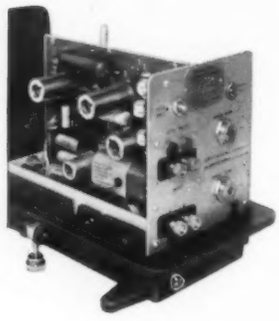
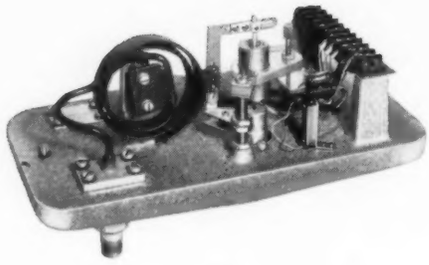


707T DP Transmitter. It provides direct conversion from differential pressure to an AC signal. No maintenance . . . insensitive to vibration . . . self-draining and venting . . . positive over-range protection to 1500 psi . . . no process fluid in contact with internal parts, double stainless diaphragm seal between process and electrical components . . . no stuffing box, no bending members, no pivots, no flexible diaphragms nor torque tube seals. No vacuum tubes, no transistors—only a simple differential transformer. Highly linear adjustable silicone damping. Perfect for all flow applications. External zero, with wide range of zero suppression. Designed for use in Class I, Group D, Division I areas.



700T Potentiometer Transmitter. Unsurpassed for sensing and transmitting Temperatures (either thermocouple or resistance elements), Load, Speed, pH, or other millivolt signals. Electronic balancing eliminates the need for slide wires, batteries, standard cells or moving parts. Continuous vernier adjustment of span or zero is simplest on the market.
Interchangeable plug-in service "cans" permit quick adaptation of one instrument for use with different primary elements. Amplifier plugs in for simple servicing. Infinite sensitivity to the input signal. Weatherproof case permits field mounting. Users consider it the finest potentiometer transmitter available.



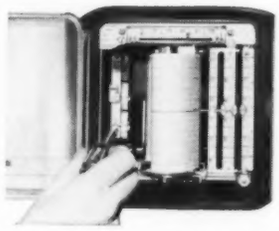
705T Pressure Transmitter. Bourdon tube senses pressure changes and moves the core of a differential transformer to change its electrical output. A simple, extremely dependable unit, built for many years of trouble-free service. Simple span and zero adjustments. Pressure ranges from absolute to 2000 psi.

• • •

See your Taylor Field Engineer for full details or write for Bulletin. Taylor Instrument Companies, Rochester, N. Y., and Toronto, Ontario.

VALVE POSITIONER

A true electro-pneumatic valve positioner, permits full utilization of the superior performance of electronic control, coupled with the power and smooth throttling action of pneumatic diaphragm motors. Pneumatic high-capacity, leakless booster relay is easily accessible for maintenance without exposing the electrical system. Unmatched stability due to powerful balanced armature reduces susceptibility to shock and vibration to a minimum. Designed for Class I, Group D, Division I areas.



1. Front Adjustments and all the features of the famous 90J Transcope Pneumatic Recorder. With chart, pen and set-point side-by-side (as in Transcope Pneumatic Recording Controllers) all pertinent process information is immediately visualized. Hence operators make fewer mistakes. All available in one 6″ x 6″ cutout.

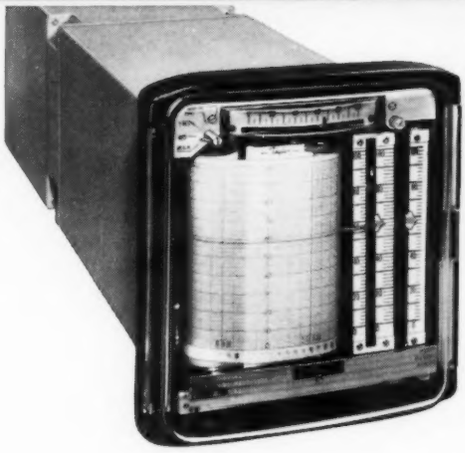
Taylor Instruments

sets new standards in

INSTRUMENTS

the highly successful TRANSCOPE* line!

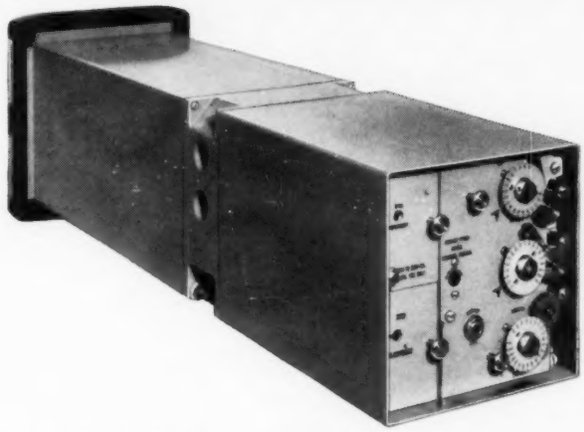
AC or DC RECORDER



Parallels electronically all the features of the TRANSCOPE Pneumatic Recorder that have won such wide acclaim. Positive, precise pen positioning provided by actual servo-motor, hundreds of times more powerful than meter type movement. Control settings and adjustments can be made from front or rear of case. Recorder can be removed without disturbing process control. Bumpless manual-to-automatic transfer is obtained without manual matching of set point and process. Plug-in Set Point Transmitter permits uninterrupted control.

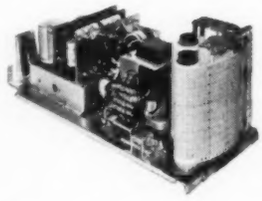
All transistorized (solid state), the 701J Recorder is unaffected by ±10% line voltage variation; thus there is no need for an expensive constant voltage source. All principal assemblies and sub-assemblies are plug-in type for flexibility and easy accessibility.

AC or DC CONTROLLER

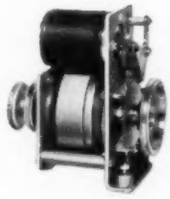


Embodies all the advantages of the most advanced control circuits. The unique diode limiter circuit permits even the two-response controllers to eliminate overpeaking on most applications. It is effective *at all times,* whether the variable is approaching control point from above or below; on changes in set point; following major process disturbances; or on start-up.

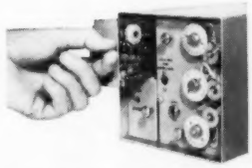
Interchangeable, plug-in assemblies permit conversion to either fast or standard reset and two-response or three-response controllers. Unparalleled rangeability makes this a universal controller. Unaffected by line voltage changes up to ±10%. Controller signal gives multiple valve operation. Output signal from 1-5 Ma feeds into any load from 0-10,000 Ohms. Plug-in assemblies: control responses, operational amplifier, AC/DC Converter, DC reference supply and controller.



2. Interchangeable Recorder Slide. Completely transistorized. Unaffected by a supply voltage change up to ±10%.



3. Powerful Servo Motor gives more precise pen positioning than ever before. More accurate records.



4. Plug-in Controller Sub-Assemblies. Printed circuit boards, mercury bottle disconnect switch.

5. Extremely Stable Controller Amplifier, utilizing latest design techniques and premium components.

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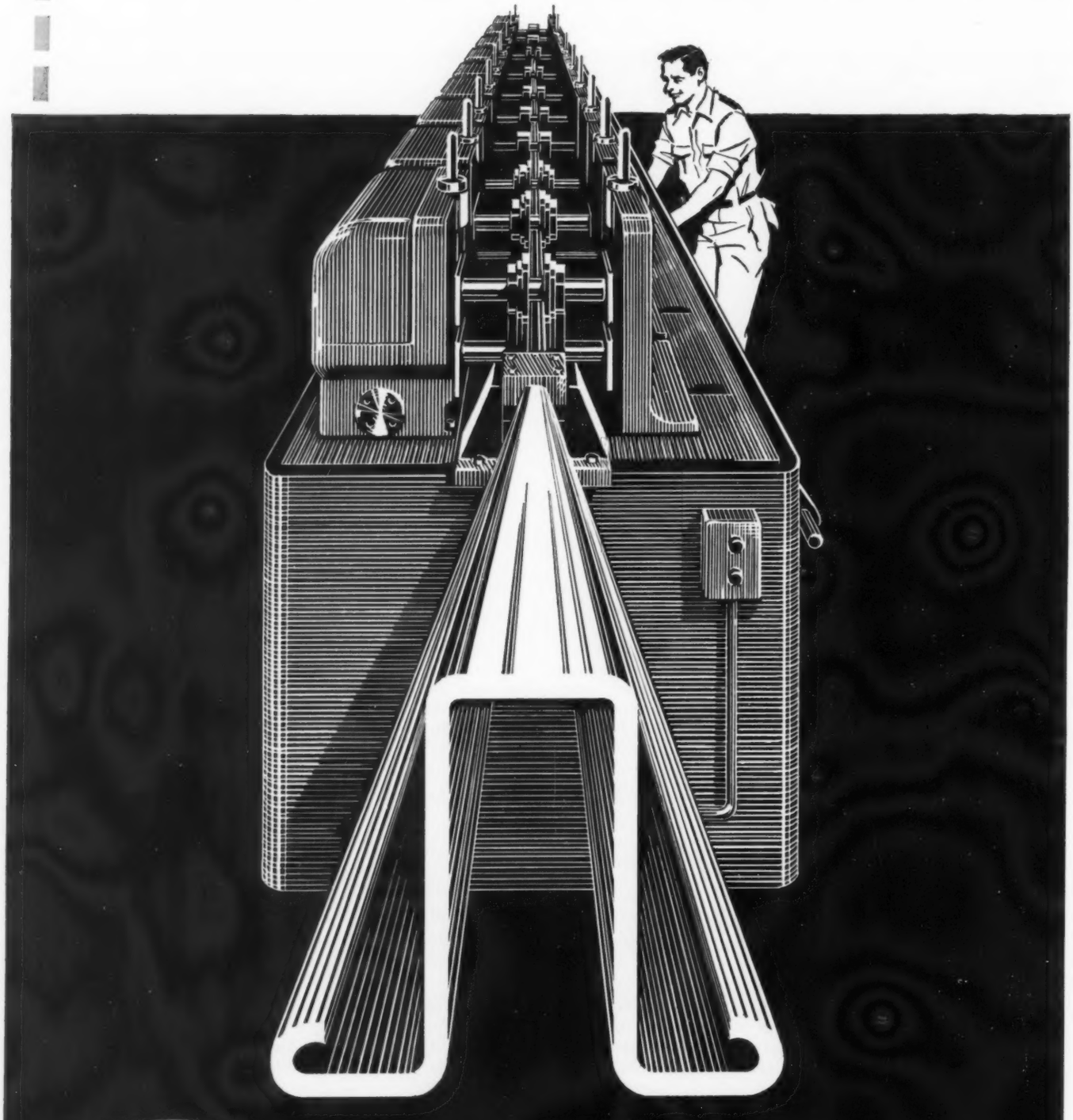

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High operating efficiency and proven reliability are the two features which set Chemico Venturi Washers apart. In the last twelve months alone, Venturi equipment was installed in eleven blast furnaces with no start-up difficulties whatsoever. In addition, all eleven units exceeded their performance guarantees. Here are five reasons for this outstanding record:

- Standardized design permits efficient scale-up for any size furnace
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- Design includes complete flexibility to handle any blowing rate
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- Newly developed high efficiency entrainment separator

Write today for further details from Chemico!

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Spray Nozzles

for hot strip spray cooling descaling roll cooling and related operations

● Greater spraying efficiency and lower equipment and maintenance costs are the advantages Spraying Systems Co. spray nozzles give you. Nozzles for hot strip cooling for example, give better steam barrier penetration and spray distribution . . . remove more heat per minute per gallon of water. Descaling nozzles provide greater impact for any volume and pressure without excessive cooling. Non-clogging design and recommended types of mounting are features that help reduce maintenance costs. Your inquiry is cordially invited for Spraying Systems Co. spray nozzle data and application information.

SPRAYING SYSTEMS CO.
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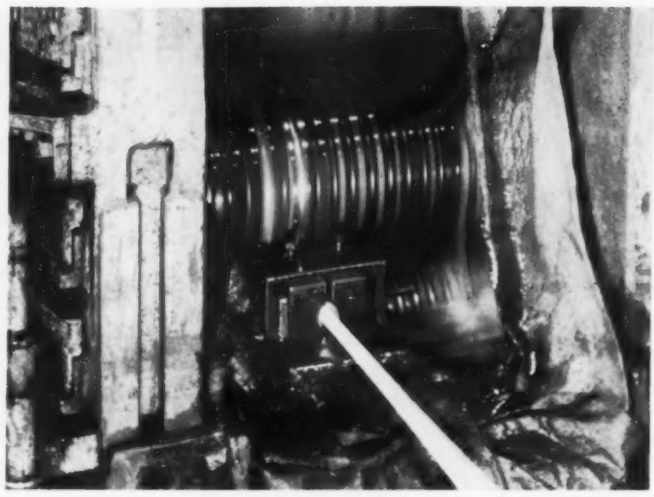
For information on Spray Nozzles and Steel Mill Applications write for Catalog 24 and Supplementary Data Sheets.



Near-white-hot rod enters roller guide housing, and forming rolls beyond. Colmonoy hard surfacing rebuilds worn guides, gives them longer life than before.

Colmonoy Cuts Roller Guide Reclamation Cost

Hard-surfacing alloys that are easy to apply save welding time. And it follows that finishing time is also reduced—easy-applying alloys produce smoother deposits. Time is money, and the maintenance department of a large stainless steel bar mill saves money by using Colmonoy No. 6 alloy to reclaim worn roller guides. With Colmonoy they reclaim three guides in the time it took to do one previously.

The superior wear-resistance of Colmonoy No. 6 added more savings by extending even further the service life of the guides. All roller guides in this plant are reclaimed with Colmonoy—again and again, indefinitely.

Colmonoy alloys are being used in many mill operations: on plate guides, edger rolls, journal sleeves, and coolant-pump parts. Write for complete information.

Smoothness is the notable characteristic of these Colmonoy-protected guides prior to finishing.

Roller guide being overlaid with Colmonoy No. 6 rod. Work rotation is operator controlled.

Ready for further service are these finished guides with mirror-bright Colmonoy surfaces.

HARD-SURFACING AND BRAZING ALLOYS

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Control Cable Savings Begin with Small Diameters

For New Work or Rewiring...

SPECIFY & BUY
ROCKBESTOS
PNR
600 VOLT CONTROL CABLE

PNR — Polyethylene • Nylon • Rockhide (PVC)

HERE'S THE PROOF WHEN IT COMES TO CONDUIT FILL

No. 12 A.W.G. (19/25)		1 CABLE PER CONDUIT				2 CABLES PER CONDUIT				3 CABLES PER CONDUIT				4 CABLES PER CONDUIT			
		Max. Cable Dia."	Number of Conductors in one Cable			Max. Cable Dia."	Number of Conductors in one Cable			Max. Cable Dia."	Number of Conductors in one Cable			Max. Cable Dia."	Number of Conductors in one Cable		
COND. SIZE		Table 11 N.E.C.	ROCK PNR	3/64"	4/64"	Table 11 N.E.C.	ROCK PNR	3/64"	4/64"	Table 11 N.E.C.	ROCK PNR	3/64"	4/64"	Table 11 N.E.C.	ROCK PNR	3/64"	4/64"
½"	New Work	.450	2-4			.243				.234				.195			
	Rewiring	.479	2-4			.276				.252				.218			
¾"	New Work	.598	5-7	2-3		.323				.311				.260			
	Rewiring	.636	5-8	2-4	2	.367				.335				.290			
1"	New Work	.762	8-14	4-7	2-4	.412	2-3			.396	2						
	Rewiring	.811	9-16	5-8	3-5	.468	2-4			.427	2-3						
1¼"	New Work	1.000	15-19	8-12	5-8	.543	4-5	2-3		.523	3-5	2-3					
	Rewiring	1.070	17-19	9-16	6-9	.618	5-8	2-4		.564	4-5	2-3					
1½"	New Work	1.170		13-19	9-12	.634	6-8	4	2	.610	6-7	4					
	Rewiring	1.248			10-14	.721	9-11	5-7	2-4	.658	6-9	4-5	2				

This is an excerpt from the Rockbestos Control Cable Conduit Fill Chart covering sizes A. W. G. 9, 12, 14. Write today for your free copy. Ask for PNR 1-58.

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ROCKBESTOS

PNR
Small Diameter
Control Cable

MORE THAN 16,000,000 FEET IN SERVICE

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MILL TYPE CRANES

to Specification..

Basically designed as required by A.I.S.E. specifications, mill type cranes built by Victor R. Browning & Co., Inc. also offer the opportunity of specifying preferences and standards prevailing in the purchaser's plant. May we have your next inquiry?

VICTOR R. BROWNING & COMPANY, Inc.
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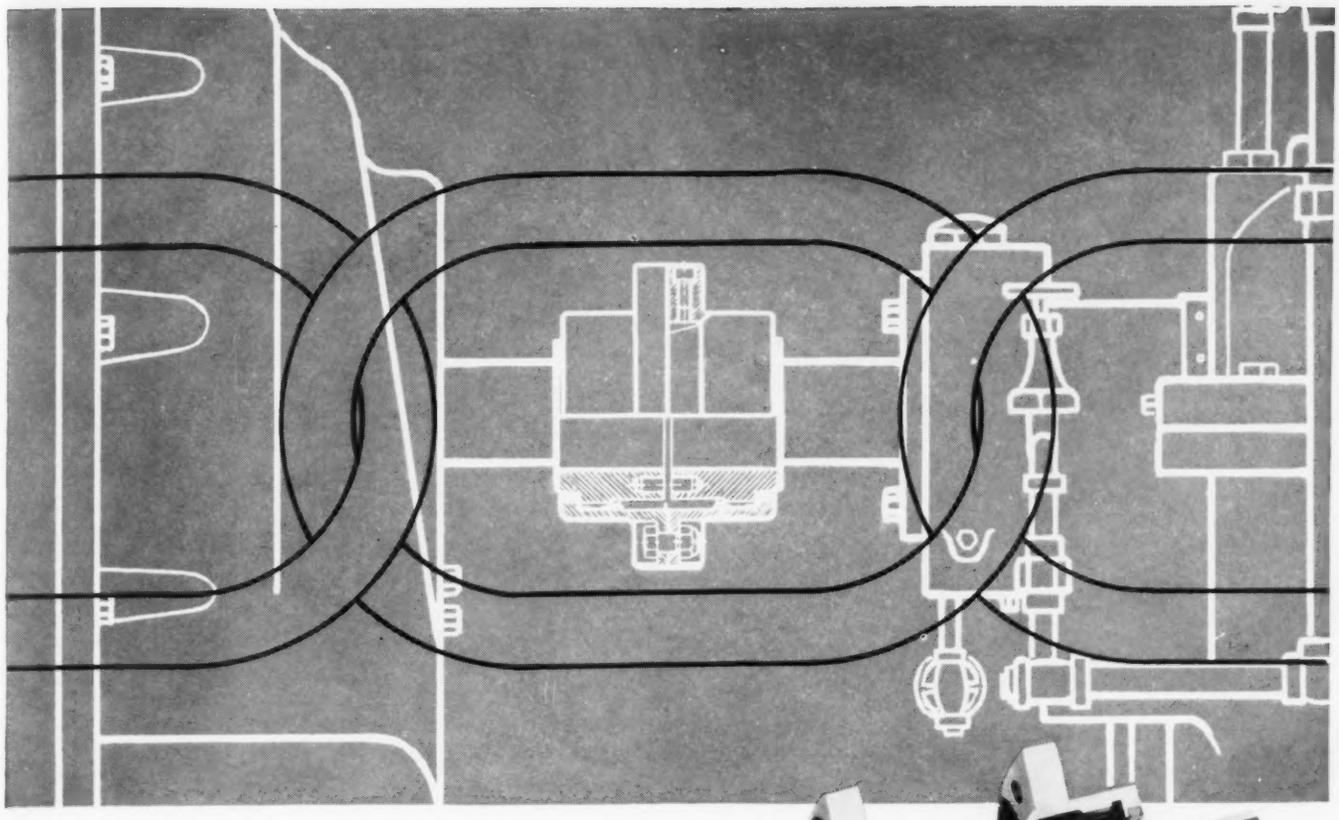
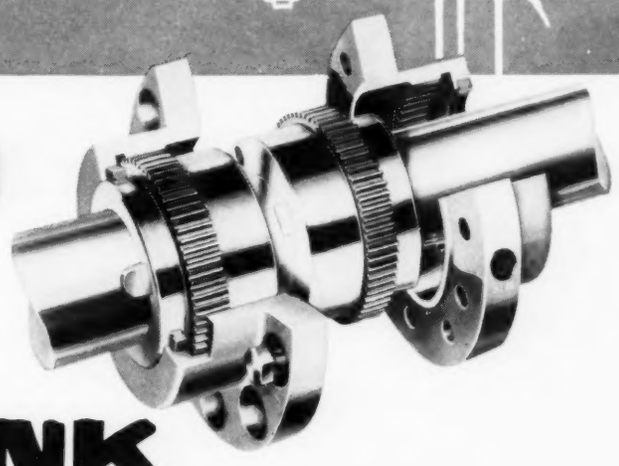
DESIGNERS AND BUILDERS OF ELECTRIC OVERHEAD TRAVELING CRANES AND HOISTS AND ELECTRIC REVOLVING CRANES





FOR WELL-DESIGNED EQUIPMENT...

SPECIFY THIS

POWER LINK

When a lot of time and effort have gone into the design of a piece of driven equipment, it makes sense to pick the power link carefully. Take a pump or compressor, for instance. No matter how well it is designed and built, for long service life and operating efficiency, it needs protection against strains due to misalignment.

Waldron gear couplings provide complete protection and positive, trouble-free drive because

They are strong . . . Hubs and cover sleeves for sizes 1¼A through 7A are machined from tough steel forgings. Hubs are keyed to the shafts. The two one-piece cover sleeves function as a single, rigid unit serving as a floating connecting link between the hubs. High strength of forgings makes possible a very compact coupling with low rotating inertia.

They are reliable . . . There are no flexible parts to bend or break and the coupling is dust, moisture, and oil tight. Patented Walflex seal is at the lowest possible diameter where centrifugal force is least. Clearance between teeth in hubs and sleeve is engineered so that an oil wedge always separates them, taking the wear.

They are available . . . Plenty of rough bore couplings, already assembled—on the shelf for *immediate* delivery. Finish bored standard couplings shipped to meet customers' schedules. We are geared up to give you realistic delivery on *any* type of couplings.

Ask for Catalog 57

JOHN WALDRON CORP.

Subsidiary of Midland-Ross Corporation

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"TURNKEY" DUST and FUME CONTROL SYSTEM
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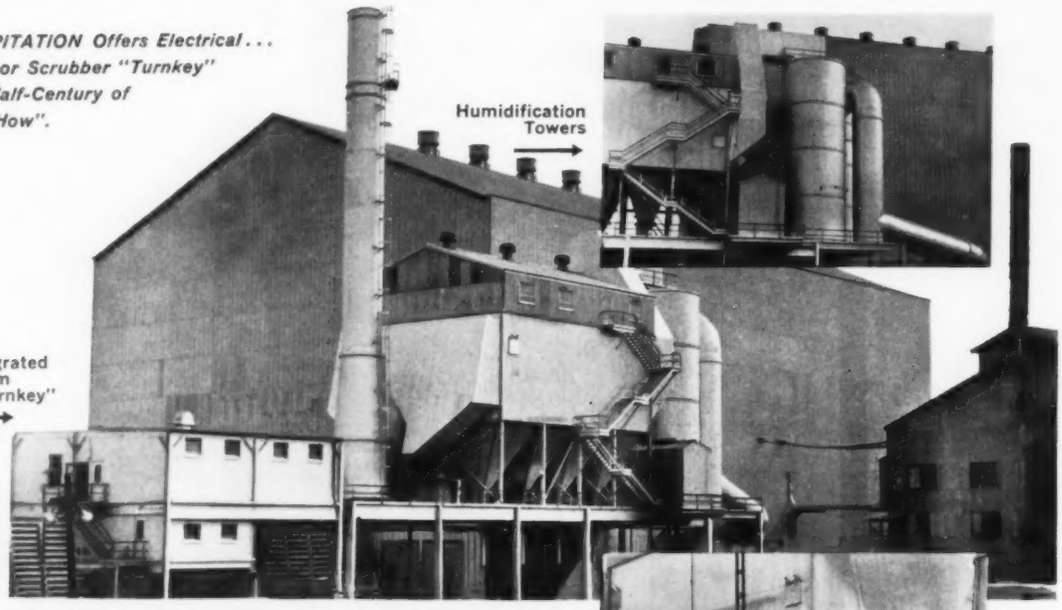
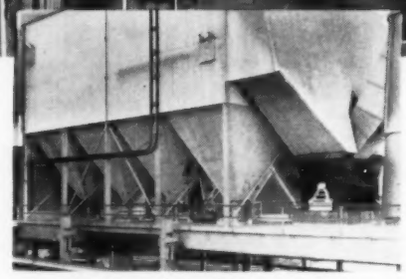
Only WESTERN PRECIPITATION Offers Electrical... Mechanical... Filter... or Scrubber "Turnkey" Systems, Backed by a Half-Century of Dust Collection "Know-How".





Fan, Hopper and Dust Disposal System

JONES & LAUGHLIN STEEL CORPORATION

the nation's fourth largest steel company—is only one of many leading organizations that have placed in Western Precipitation's hands responsibility for designing, engineering and constructing a complete "turnkey" system for controlling dusts and fumes from industrial operations

The J & L installation is of a type pioneered by Western Precipitation—control of dust and fume from electric furnaces by use of Cottrell Precipitators. For J & L's Cleveland Works, Western Precipitation supplied and installed flame traps, flues, humidification towers, Cottrell Precipitators, including superstructures and support structures, fans, exhaust stack, instrumentation and other accessory equipment for operation of the complete system—*all under one overall "turnkey" contract!*

If dust, fume or fly ash is a problem in *your* operations, why not investigate the many advantages of putting Western Precipitation's 50 years of "know-how" on the job? You get an unbiased recommendation because Western Precipitation is the only organization offering wide field experience in ELECTRICAL (Cottrell Precipitators) ... MECHANICAL (Multiclone Collectors) ... FILTER (Dualaire or Thermo-Flex Systems) ... and SCRUBBER (Turbulaire-Doyle units).

Best of all, Western Precipitation can install this equipment—complete with all accessory units, blowers, ducts, materials-handling systems, substructures, etc.—under one overall contract, one overall guarantee, one overall responsibility.

Our nearest representative will gladly supply full details. Or write direct.

Other Typical Western Precipitation "TURNKEY" Installations

INDUSTRY	INSTALLATION
Rock Products	Salt Cake Drying Kilns, Pyrobor Processing ... American Potash & Chemical Co., Trona, California
Steel	Open Hearths ... U. S. Steel Corp., Homestead, Pa.
Steel	Oxygen-blown Vessels, Cupolas ... Acme Steel Co. Riverdale, Illinois
Cement	Wet Process Cement Kilns ... Arkansas Cement Company Foreman, Arkansas
Metallurgical	Lead Sintering Machines ... The Bunker Hill Company Kellogg, Idaho

COTTRELL Electrical Precipitators
MULTICLONE Mechanical Collectors
CMP Combination Units
DUALAIRE Jet-Cleaned Filters
THERM-O-FLEX Hi-Temp Filters
TURBULAIRE-DOYLE Scrubbers
HOLO-FLITE Processors
HI-TURBIANT Heaters

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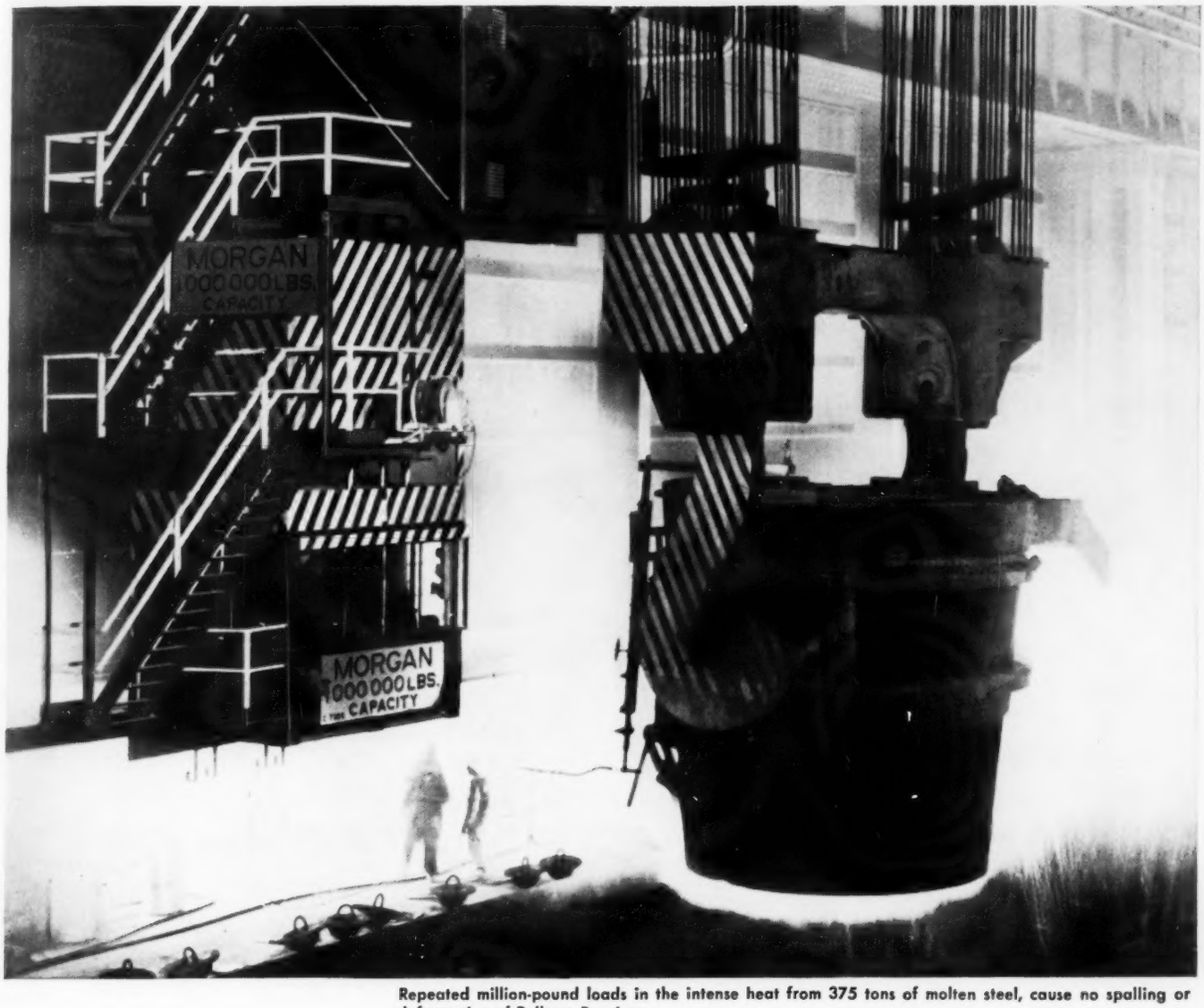


Repeated million-pound loads in the intense heat from 375 tons of molten steel, cause no spalling or deformation of Rollway Bearings.

1,122,000 Pounds Ride on 68 Rollway Bearings

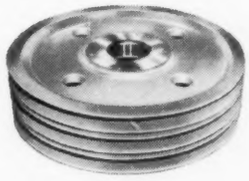
One of the largest in the world, this 500-ton Morgan-built ladle crane is Rollway equipped in many positions.

Sixty-eight maximum-type, solid-cylindrical bearings—mounted without inner races—lift and lower the 1,122,000-pound weight of the lifting beam, ladle hooks, ladle and white-hot steel.

Rollway Tru-Rol® type bearings are used in the two General Electric 360 HP – MD-620 Hoist motors which lift the weight of the ladle and its molten metal content.

The maximum-type bearings in the hoisting sheaves are mounted directly on the shaft without inner races, which greatly simplifies assembly for applications of this size.

Thrust bearings in the 25-ton and 75-ton auxiliary crane hooks are standard Rollway precision types with broad-area contact between rollers and plates to prevent Brinelling and assure freedom of rotation under the heaviest loads.



Sheaves ready for assembly on shaft and installation in lifting beam.

For bearings that accomplish the extraordinary in an ordinary manner, write, wire or 'phone Rollway Bearing Co., Syracuse 1, N.Y.

ROLLWAY® BEARINGS

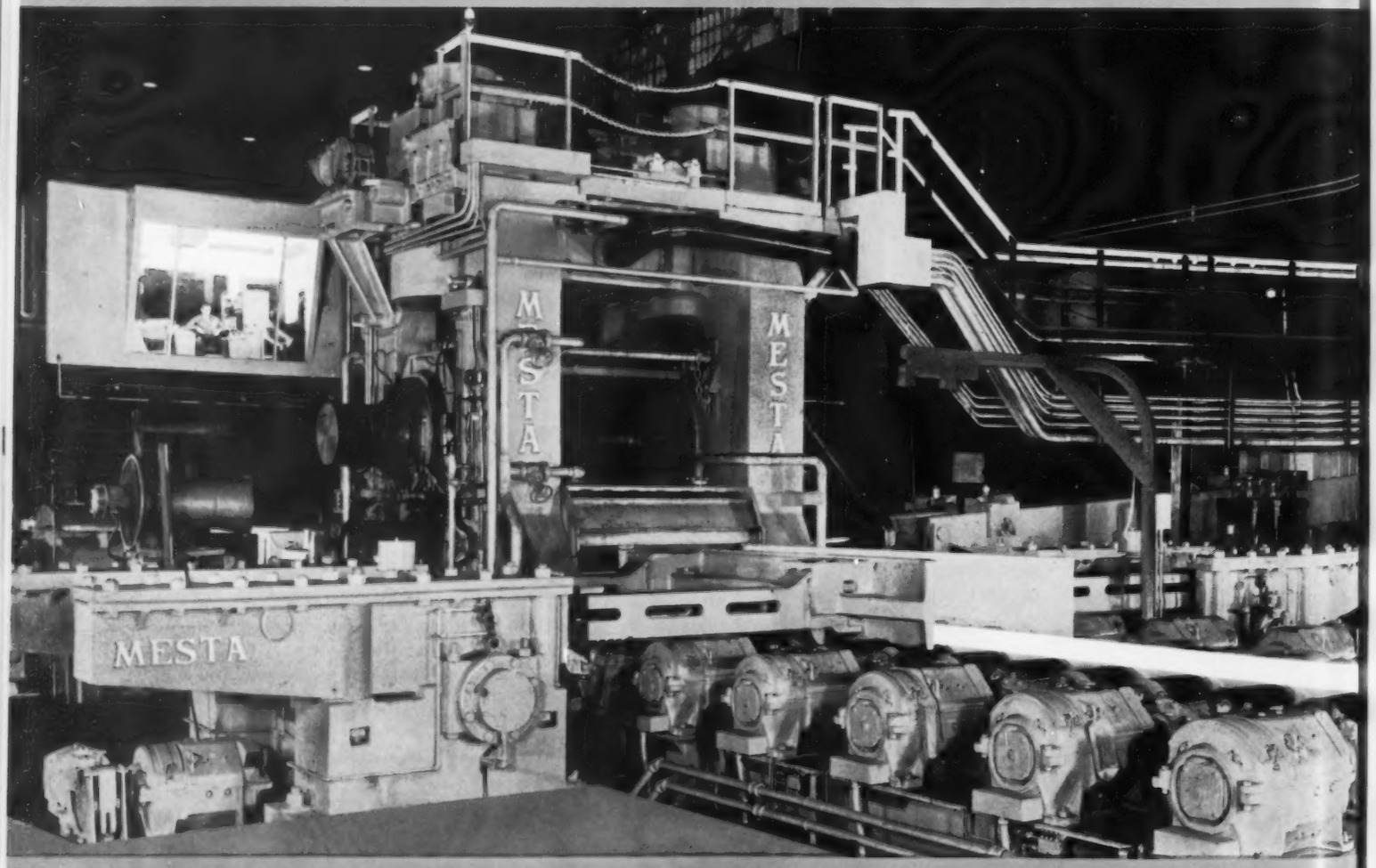
ENGINEERING OFFICES: Syracuse • Boston • Chicago • Detroit • Toronto • Pittsburgh • Cleveland • Seattle • Houston • Philadelphia • Los Angeles • San Francisco

Designed and Built by MESTA

FOR

The Exciting New J&L's
Cleveland Works

A MESTA 45" Two-High Reversing Slabbing Mill, including ingot buggy, manipulator, and tables and a MESTA 80" Four-High Reversing Roughing Mill, with Vertical Edger, motor driven side guards, and tables installed at the Cleveland Works of the exciting new Jones & Laughlin Steel Corporation.



Designers and Builders of Complete Steel Plants

MESTA MACHINE COMPANY

PITTSBURGH, PENNSYLVANIA

Personnel News...

Paul C. Ely was appointed assistant vice president—operations, National Tube Division, United States Steel Corp. Mr. Ely, who has been general superintendent of National Tube's Gary Works, will be in charge of tubing specialties manufacturing. Mr. Ely joined National Tube in 1927 at its Pittsburgh headquarters as a metallurgist. In 1930 he was transferred to the company's National Works at McKeesport as a test engineer. Mr. Ely became assistant superintendent of the galvanizing department there in 1933 and in 1935 was promoted to superintendent of the galvanizing department. In 1941 he was transferred to the company's Lorain, Ohio, Works and occupied various management positions there and in 1950 was appointed superintendent of the open hearth and foundry departments. In June of 1952, Mr. Ely was made division superintendent of Lorain Works in charge of all steelmaking. In 1954 he was named general superintendent of National Tube's Gary Works.

Julius H. Strassburger has been advanced from the position of director to vice president—research and development of National Steel Corp. He will be succeeded as director of the department by **Dr. Ivor E. Campbell** who comes to National Steel from the Batelle Memorial Institute.

Mr. Strassburger joined the National Steel organization in 1924 as a combustion engineer at its Weirton Steel division. He was promoted to manager of service and maintenance in 1941; assistant general superintendent in 1951; and assistant vice president—engineering in 1953. In 1956, he became assistant vice president—engineering of National Steel from which position he advanced to the directorship of the new research and development activity.

Since 1950, Dr. Campbell has been chief of the division of inorganic chemistry and chemical engineering of the Batelle Memorial Institute. He joined the Institute staff in 1943 as a research chemist and advanced to assistant supervisor of the division of nonferrous metallurgy in 1948.

Russell H. Loutzenhiser has been named division vice president—production Jones & Laughlin Steel Corp.'s stainless and strip division. He formerly was in charge of production at the Division's Detroit, Mich., and Louisville, Ohio, plants. **Eugene V. Mort** has been promoted to division general manager of production. He formerly was manager of production for the strip producing plants of the division.

Mr. Loutzenhiser was employed as a melter for Timken Steel and Tube, Canton, Ohio, from 1928 until 1940. He joined Crucible Steel Co. of America's Midland, Pa., Works as general melting foreman in 1940, and was promoted to superintendent of the Electric Furnace Department two years later. He joined Rotary Electric Steel Co. as superintendent of the Electric Furnace Department in Detroit and was named plant superintendent in 1953. He was named vice president of production when Rotary became J&L's Stainless Steel Division in 1957.

Mr. Mort joined the Cold Metal Products Co. at the Youngstown, Ohio, plant in 1939 as a laborer. In succeeding years, he became a roller, sales clerk, assistant manager of specialty sales; manager of the Kenilworth, N. J., plant, and, in 1954, manager of the Youngstown plant. He was named division manager—production in 1957 when the Cold Metal Products Co became the J&L Strip Steel Division.

Malcolm B. Antrim was promoted to the position of manager—engineering and construction, Lukens Steel Co. He will direct all engineering, the designing of plants and equipment and construction of plants, equipment and utilities. He has been with Lukens since 1941 and has most recently been the company's project manager on its expansion program.

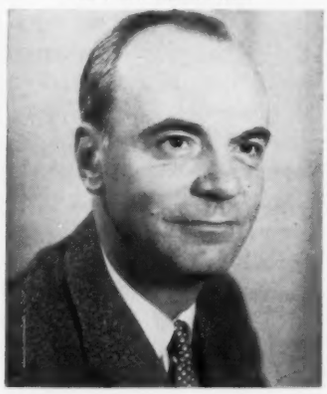
Joseph L. Block, formerly president and chief executive officer, Inland Steel Co., was named chairman and will remain chief executive officer. The company has not had a chairman since the retirement of **Clarence B. Randall** in 1956. **Philip D. Block, Jr.,** formerly senior vice president in charge of raw materials, has been elected vice chairman and will assume the responsibilities of the chairman in his absence. **John F. Smith, Jr.** has been elected president. He has been

P. C. ELY

J. H. STRASSBURGER

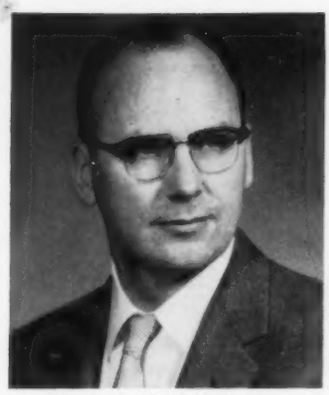
R. H. LOUTZENHISER

M. B. ANTRIM



C. W. CRAVENS

J. R. LOWEY



N. W. BLAKELY

T. H. HAGAN

vice president in charge of sales since 1952. **Hjalmar W. Johnson,** vice president in charge of steel manufacturing for the last ten years, has been elected vice president in charge of planning and research. **Francis M. Rich** becomes vice president in charge of steel manufacturing after serving for nine years as general manager of Indiana Harbor Works. **Lemuel B. Hunter** has been elected to the newly created position of vice president—administration, after serving for two and one-half years as assistant to the president. **Carl B. Jacobs,** who has been general manager of raw materials, was named vice president in charge of raw materials.

Charles W. Cravens has been named manager of the Cleveland steel plant of Republic Steel Corp. He succeeds **Mowry E. Goetz** who retired at the end of the year after 50 years in the steel industry. Mr. Cravens, who had been assistant district manager, is succeeded in that post by **John R. Lowey** who had been general superintendent.

Mr. Cravens joined the Central Alloy Division of Republic Steel in 1933. After seven years as a sales engineer with the Alloy Sales Division, he transferred to the operating department in 1940 to work with electric steelmaking furnaces. He went to Republic's South Chicago plant as senior melter in the tilting and electric furnace department there in 1942. In 1945 he was appointed assistant superintendent of the No. 1 open hearth shop there and in 1947 became assistant superintendent of the tilting and electric furnace department. He was promoted to superintendent of the No. 2 open hearth shops at Cleveland in 1953, became second assistant district manager the following year and assistant district manager in 1956.

Mr. Lowey was named general superintendent of the Cleveland plant last October. He had joined Republic at Chicago in 1935 as a junior engineer. He advanced to foreman of the boiler and welding shop there in 1937 and four years later was promoted to general millwright foreman. In 1945 he was named general shop foreman at the Cleveland steel plant, became assistant superintendent of the mechanical department in 1950 and superintendent in 1957.

Nelson W. Blakely has been appointed general manager of Wheeling Steel Corp.'s Benwood Works, succeeding **H. Nelson Lang,** who has been named general manager of the company's Steubenville Works. Mr. Blakely has been with Wheeling Steel since 1951 when he was named assistant chief plant engineer of the Steubenville Works. Two years later, he was appointed chief plant engineer at Steubenville. In 1955, he was placed in charge of the company's major construction program at the Steubenville and Yorkville plants. He has been assistant general manager at Benwood since 1957.

T. H. Hagan has been appointed assistant district manager of Republic Steel Corp.'s Southern Steel District. He was previously general superintendent. Mr. Hagan joined Gulf States Steel Co. at Gadsden, Ala., in 1930 as a combustion engineer. In 1940, after Republic had acquired the Gulf States plant, Mr. Hagan became general foreman of the sheet mill. He was made superintendent of the power plant in 1942 and was moved back to the sheet mill in 1943 as superintendent. In 1953 he was advanced to the post of superintendent of steel works and two years later became general superintendent for the district.

Frederick G. Jaicks has been appointed general manager of Inland Steel Co.'s Indiana Harbor Works. **Louis R. Berner** was named to succeed Mr. Jaicks as assistant general manager of primary production and **Richard G. Phelps** was appointed to Mr. Berner's former post of manager, steel production. Also, **Albert M. Kroner** was named superintendent of No. 3 open hearth, succeeding Mr. Phelps. **Francis D. Nelson** was appointed assistant superintendent, No. 3 open hearth, the job formerly held by Mr. Kroner. Other promotions announced include those of **Michael Tenenbaum** as assistant general manager of technical services and **Joseph D. Mayer** as administrative assistant to the general manager.

Thomas G. Lewis has been appointed purchasing agent for the Youngstown Sheet and Tube Co. Mr. Lewis joined Youngstown Sheet and Tube as an office boy in the purchasing department in 1925. He subsequently worked as a piercing mill operator, invoice clerk, chief invoice clerk, chief purchasing department clerk and buyer before becoming assistant to the director of purchases in 1955. The following year he became assistant purchasing agent, the position he held at the time of his most recent promotion.

Robert L. Felt has been appointed product metallurgical engineer in Crucible Steel Co. of America's Metallurgical Division in Pittsburgh. He was formerly assistant chief metallurgist at the company's Midland,

Charging one of the eleven J&L Cleveland Works open hearth furnaces recently converted to 35% gas firing. Increased efficiency cuts melt time by 5 to 10%.

Gas cuts melt time up to 10% in 11 open hearths at "exciting new" J&L Cleveland Works

Since converting eleven open hearths to 35% gas firing, J&L has cut melt time between 5 and 10% at its Cleveland Works. Conversion to gas firing was accomplished as part of a $90,000,000 plant expansion program recently completed.

Gas is delivered to the shop floor at 50 psi pressure through a new 20-inch main serving the plant.

Faster burning, sharper cutting characteristics of gas account for the savings in melt time. Increased open hearth production feeds the plant's new rolling facilities that include 10 new soaking pits, 15 new annealing furnaces and a new continuous automatic scarfer . . . all using natural gas as the principal fuel.

The East Ohio Gas Company is privileged to serve Jones & Laughlin's new Cleveland Works facilities in the production of quality steels for American industry.

THE EAST OHIO GAS COMPANY

Pa., Works. Mr. Felt joined Crucible in 1951 as staff metallurgist at the Midland plant. He was named assistant chief metallurgist in 1955. He was formerly a metallurgist with Universal-Cyclops Steel Co. and Republic Steel Corp.

Herman F. Kaiser was named divisional superintendent of Republic Steel Corp.'s Canton, Ohio, steel plant. In other appointments at the company's Canton plant, **Raymond C. Moore** has been named superintendent of the blooming mill, succeeding Mr. Kaiser, and **Herbert C. Johnston** succeeds Mr. Moore as assistant superintendent of the plant's blooming mill.

Mr. Kaiser is a veteran of 30 years' service with Republic, all at the Canton plant. He started in 1928 and served in numerous capacities in the blooming mill before being named turn foreman in 1949. He was named assistant superintendent of the blooming mill in 1954, and superintendent in March 1956.

Mr. Moore started with Republic in June, 1940, as a helper in the chemical laboratory. He later served as shear foreman and turn foreman in the blooming mill. In 1956 he was named assistant superintendent.

Mr. Johnston has been with Republic in Canton since 1941, where he also has served in numerous capacities in the blooming mill. He was named turn foreman in 1956.

Robert H. Henke has been appointed assistant manager of Republic Steel Corp.'s Central Alloy District (Canton and Massillon, Ohio). Mr. Henke has been manager of quality control at Allegheny Ludlum Steel Corp.'s Brackenridge, Pa., Works since 1952. Prior to that he was assistant chief metallurgist at Brackenridge for two years. From 1945 to 1950 he was employed in the plant's research laboratories and also in the sales development and engineering service department. Before joining Allegheny Ludlum he was employed by A. M. Byers Co. at the Ambridge, Pa., Works, and also at the Duquesne Works of the United States Steel Corp.

James C. Eaton has been named assistant to the vice president of operations of Latrobe Steel Co. He was formerly production superintendent of the laminations department, and served as staff assistant to the works manager of Allegheny Ludlum Steel Corp.'s Brackenridge, Pa., Works.

Eugene J. Hochdanner has been appointed chief engineer at Latrobe Steel Co. He will be in charge of engineering design, installation and maintenance of buildings, equipment and facilities. Mr. Hochdanner joins Latrobe after serving as works engineer at Allegheny-Ludlum Steel Corp.'s Brackenridge Works. Previously, he was superintendent of construction and general foreman of maintenance.

Robert W. Hiller has been appointed assistant to the general manager of the Engineering Works Division of Dravo Corp. He has been plant engineer for the division since 1946. Mr. Hiller joined Dravo in 1940. He was previously associated with Blaw-Knox Co. and Struthers Wells Co. as an engineer.

John W. Freund was named manager of the Central District, Koppers Co., Inc., Metals Products Division. At the same time, **Sidney H. Fedan,** former assistant manager, Sound Control Department, was named to succeed Mr. Freund as manager of the Western District. Mr. Freund joined the engineering department of Koppers in 1948 and was named an industrial engineer in the piston ring department in 1951. In 1953 he was appointed a sales engineer in the Metal Products Division's district office at Detroit, Mich., and was made manager of the Division's Western District in 1957. Mr. Fedan joined Koppers in 1941. He was named manager of the aircraft propeller and industrial fan department in 1945 and was appointed assistant manager, Sound Control Department, in 1956.

J. J. Munns, executive vice president of National Steel Corp., has retired. Mr. Munns came to National Steel in 1935 to establish the first quality control department in the steel industry at National's Weirton Steel Division. He secured his first job with Bethlehem Steel Co. on the construction of new mills at Steelton, Pa. Later assignments took him to plants at Sparrows Point, Md., and Fore River, Mass., where he became superintendent of fabricating shops and shipbuilding. He entered the employ of Continental Can Co., advancing through various positions to manager of the company's Chicago operations. He resigned from this position to become vice president—quality control of Weirton Steel Co. In 1954, Mr. Munns became vice president of research and quality control for National Steel Corp., advanced to senior vice president in the following year and executive vice president in 1956.

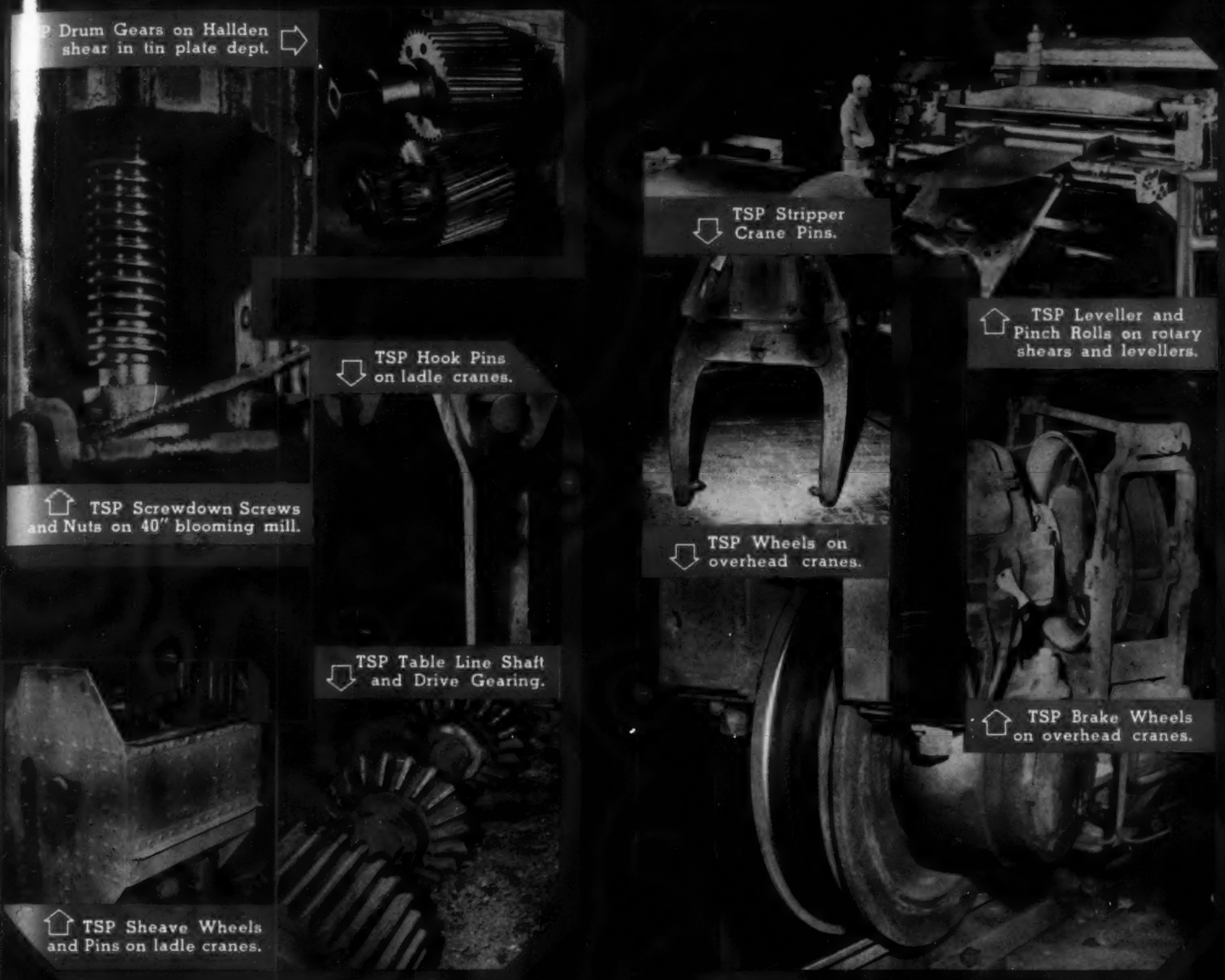
W. H. Boyce has become affiliated with Electrical Engineers Equipment Co. as manager, Industrial

H. F. KAISER

R. H. HENKE

J. C. EATON

E. J. HOCHDANNER


P Drum Gears on Hallden shear in tin plate dept.
TSP Stripper Crane Pins.
TSP Leveller and Pinch Rolls on rotary shears and levellers.
TSP Hook Pins on ladle cranes.
TSP Screwdown Screws and Nuts on 40" blooming mill.
TSP Wheels on overhead cranes.
TSP Table Line Shaft and Drive Gearing.
TSP Brake Wheels on overhead cranes.
TSP Sheave Wheels and Pins on ladle cranes.

TSP in service for 50 years at JONES & LAUGHLIN

"Tool Steel Process" products went into the exciting new Jones & Laughlin Steel Corporation in 1909. Today, TSP hardened products are in every operating department of not only the Cleveland Works but all J & L plants. TSP products now in use include screwdown screws, gears and pinions for all services; track and sheave wheels; leveller, pinch, back-up and coiler carrying rolls, cold rolling rolls, arbors, shafts and axles, sprockets, screws and nuts, and mill pinions. TSP products are used because actual service records in the nation's steel mills prove conclusively TSP superiority over any competitive material previously used.

All TSP products are hardened by our special process. The file hard surface to full depth of permissible wear gives maximum life. The core, refined for toughness and ductility gives maximum strength. You receive a written guarantee that TSP products will give a longer life in the same service than any other product. TSP products are the standard of quality, your best investment.

THE TOOL STEEL GEAR AND PINION CO.
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New Jetting Tool To Clean Tube Bundles Saves Thousands Of Dollars

The new high-pressure hydraulic tool, shown above, is currently saving thousands of dollars for companies in the refining, chemical, and petrochemical industries. It is the jetting tool developed by Dowell to remove deposits from heat exchanger tube bundles.

Previous methods of cleaning these bundles have been costly, time-consuming and often inadequate. Many times bundles had to be replaced completely because of the lack of a suitable cleaning method.

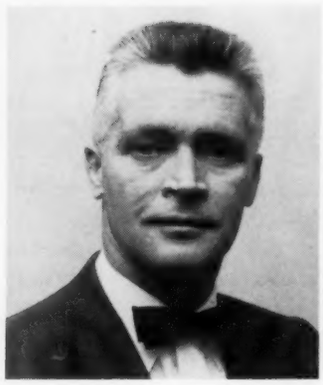
This new Dowell tool has a remarkable record of thorough, fast cleaning. For example, a slurry reboiler exchanger bundle, three feet in diameter and 16 feet long, was fouled with deposits of coke and asphalt. After being jetted from only one side, the bundle was thoroughly clean. Time required: less than one hour.

The tool holds the bundle in place for cleaning and has flanged rollers for rotation. The jet-head is manipulated automatically so that all tube spaces are covered. The jetted liquid can be either water or chemical solvents.

This high-velocity jetting device is another example of the new ideas Dowell continues to offer in chemical cleaning to help you cut your costs. Whatever the cleaning problem in your plant, call Dowell for an engineered recommendation. Dowell — the largest, the oldest, the most experienced chemical cleaning service — Tulsa 1, Oklahoma; and 165 stations and offices in major industrial centers.

Chemical cleaning service for all industry DOWELL

DIVISION OF THE DOW CHEMICAL COMPANY



R. M. TRENT (left)
W. E. THOMAS (center)
A. F. MORRIS, JR. (right)

Division. He was previously associated with Delta-Star Electric Div., H. K. Porter Co., Inc.

Ralph M. Trent has been elected president of Pangborn Corp. Mr. Trent has been associated with Pangborn for 28 years. He was district manager in Pittsburgh, Pa., for 14 years and West Coast district manager for 10 years. In 1957 he was named executive vice president.

William E. Thomas has been appointed assistant to the vice president of operations United Engineering and Foundry Co. Mr. Thomas started with United at the Youngstown, Ohio, plant in 1940 where he advanced to assistant machine shop superintendent. In 1955 he was transferred to the company's Pittsburgh office as manufacturing assistant, which position he held until the present.

A. Fred Morris, Jr. was named sales manager of the Morgan Engineering Co. He joined Morgan in 1938., and worked in the Engineering and Estimating Departments until 1946 when be transferred to Sales. In 1954 he was elected to the board of directors.

John B. Hunley has been appointed superintendent of labor and transportation at the Buffalo, N. Y., plant of Republic Steel Corp. He succeeds **W. G. Miller** who retired recently. **Terence F. Woods,** who had been general labor foreman at the plant, has been promoted to assistant superintendent of labor and transportation, succeeding Mr. Hunley.

Mr. Hunley joined Republic in 1936 as an industrial engineer. He was appointed assistant superintendent of labor and transportation in 1952.

Mr. Woods joined Republic in 1923, became a foreman in the labor department in 1935 and was named general labor foreman in 1939.

Emil A. Axelson has joined the sales staff of the Refractories Division, H. K. Porter Co., Inc. He was previously with Bethlehem Steel Co. as assistant open hearth superintendent.

Walter L. Davidson has been appointed sales manager of the Engineering Works Division of Dravo Corp. Mr. Davidson joined Dravo in 1942 and most recently served as manager of the General Sales Department.

V. W. Copcutt has been named marketing manager Research-Cottrell, Inc. Mr. Copcutt formerly was assistant manager, product engineering and prior to that had worked seven years as process engineer on pre-contract work for the firm.

T. S. Banghart has been named manager of switchgear sales; **James S. Holtzinger,** manager of application engineering; and **Howard D. Tindall,** manager of small power transformer sales, Pennsylvania Transformer Division, McGraw-Edison Co.

Mr. Banghart joined Pennsylvania Transformer in 1957 as headquarters switchgear specialist. For six years prior to that, he was an application engineer in the New York sales office of I-T-E- Circuit Breaker Co.

Mr. Holtzinger joined Pennsylvania Transformer as application engineer in 1957, after an eight-year association with Long Island Lighting Co.

Prior to joining Pennsylvania Transformer in 1956, Mr. Tindall was vice president and general manager of the Gardner Division of Federal Pacific Electric Co. Earlier, he was vice president of Moloney Electric Co., where he also served as assistant chief engineer.

John K. Kuenzig has been named superintendent of the Brier Hill Coke Plant of the Youngstown Sheet and Tube Co. Mr. Kuenzig was senior operating engineer of Koppers Co., Inc., from 1947 to 1958. He joined Youngstown Sheet and Tube last June as special engineer. Mr. Kuenzig succeeds **Elwyn T. Gants** as superintendent of the plant. Mr. Gants has retired after nearly 41 years of service with Youngstown Sheet and Tube.

Wade R. Trimbur has been named assistant district industrial engineer at Republic Steel Corp.'s Youngstown, Ohio, plant. Mr. Trimbur has been with the company since 1950 when he started as a thermocouple maker. He was transferred to the industrial engineering department in 1951 and in 1953 became a time study engineer, the position he held until taking over his new duties.

Guy F. McCracken has been appointed chief control metallurgist at the Crucible Steel Co. of America's Midland Works. He was formerly general supervisor of the Metallurgical Division at the company's Sanderson-Halcomb Works in Syracuse, N. Y. Mr. McCracken joined Crucible in 1949 as a metallurgist in the Syracuse plant. He was named supervisor of mill test control in 1952 and contact metallurgist in 1954. He was appointed general supervisor of metallurgical control in 1956.

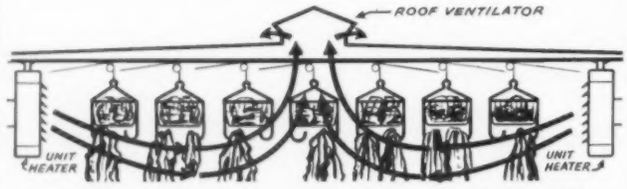
S. C. KILLIAN

T. F. NAYLOR

Stanley C. Killian has been appointed vice president and general manager of the Delta-Star Electric Division, H. K. Porter Co., Inc. Mr. Killian has served on the Delta-Star executive staff for six years, most recently as vice president and assistant general manager, and previously as chief engineer. He joined Delta-Star in 1934 from a consulting engineering firm. **C. Stuart Beattie,** who for the past eight years has operated Delta-Star will continue to serve the Porter Division in a part time consulting capacity.

Thurman F. Naylor has been appointed sales manager of the Metal Products Division of Koppers Co., Inc. He joined Koppers production department in 1942, and later was assigned to the engineering department of the Division.

OVERHEAD CLOTHING STORAGE
WITH
MOORE LOCKERBASKETS
SELF-VENTILATING



With Moore Lockerbaskets, clean warm air from unit heaters is blown over clothes and exhausted through roof ventilators, removing all odors and leaving clothes fresh and dry.

100% EXPOSURE TO AIR AND LIGHT
50% SAVING IN LOCKER ROOM COST
SPACIOUS, OPEN ROOM AREA

Overhead Lockerbaskets leave the floor unobstructed, reduce size of locker room by one-half. Open floor areas eliminate congestion and crowding, suggest spaciousness and reflect cleanliness. Advanced change room design calls for overhead storage.

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Obituary

A. J. Fisher, general manager, Johnstown plant, Bethlehem Steel Co., died January 30. He was 60. Mr. Fisher began his steel mill career in 1924, joining Bethlehem as assistant master mechanic of the Sheet and Tin Division at Sparrows Point, Md. He became fuel engineer at Sparrows Point in 1929, and in 1947 moved to Bethlehem, Pa., as assistant engineer of construction. He was appointed general manager at Johnstown in 1952. Mr. Fisher presented numerous papers before various engineering societies and won the AISE Kelly award in 1943 and in 1947. He was president of AISE in 1948.

A. J. FISHER

Theodore Kauffmann, Sr., chairman of board of directors, the S. Obermayer Co. and the Ramtite Co., died January 14 at the age of 92.

Charles S. Redding, chairman of the board of directors and former president of Leeds & Northrup Co., died January 2. He was 75.

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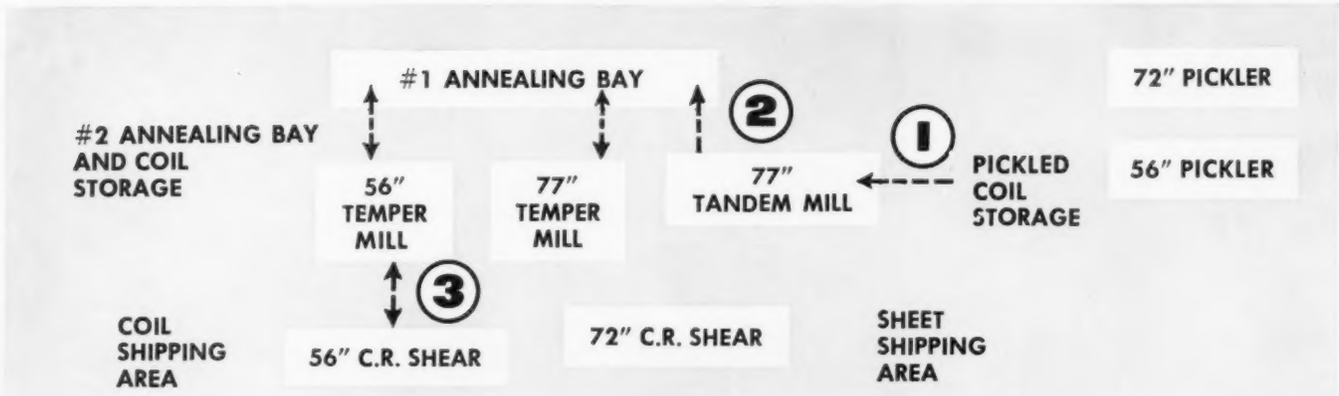
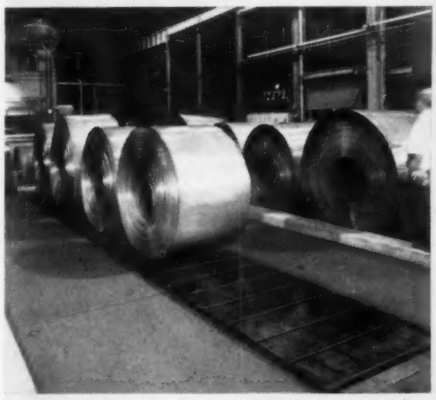
Flying Shear Lines
Power Squaring Shears • Automatic Re-squaring • Corrugating
Culvert • Steel Mill Equipment

STAMCO, Inc., New Bremen, Ohio

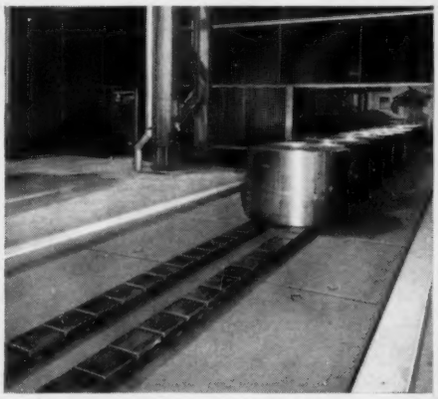
"Kid glove" handling for hot and cold coils



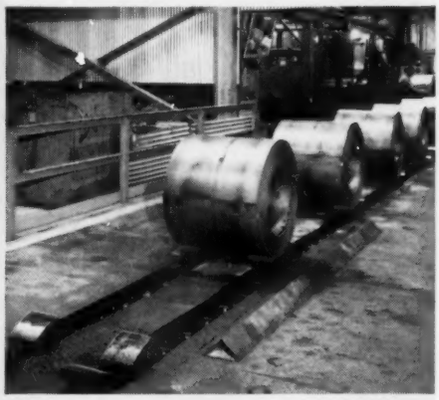
NEW COLD FACILITIES AT J & L CLEVELAND WORKS (Link-Belt conveyors furnished through E. W. Bliss Co.)



1 **60,000-LB. COILS** are fed to tandem mill by Link-Belt pallet-top conveyor. The four-stand mill is believed to be fastest, most powerful in the world.



2 **COILS RIDE TO ANNEALING BAY** in steady, continuous flow on this Link-Belt double-strand, flat-top conveyor. Travel is gentle . . . there's no scuffing of edges.



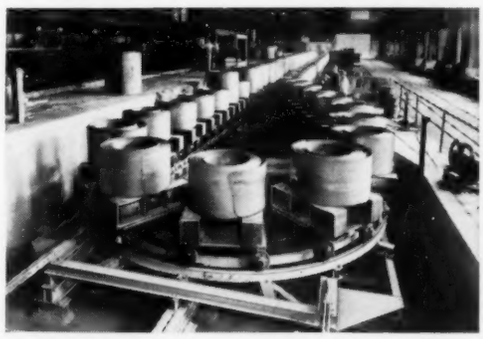
3 **TRANSPORTATION FROM TEMPER MILL** is provided by Link-Belt saddle-top conveyor. Coils then travel through shear lines to warehouse or to shipping area.

LINK-BELT conveyors carry coils smoothly, gently at the exciting new J & L Cleveland Works

Link-Belt coil conveyors are a prominent part of the recently completed multi-million dollar expansion of Jones & Laughlin's Cleveland Works. Serving both hot and cold mills, rugged Link-Belt conveyors provide the controlled, gentle handling necessary for maximum yield . . . minimum scrap loss.

Throughout the steel industry, Link-Belt is helping to boost production, cut waste, improve safety, reduce physical effort. Single machine or complete system, mills rely on Link-Belt for efficient handling of bulk materials, coils and steel in its many other forms.

We will gladly work with your engineers, consultants and builders of mill and process equipment. Contact your nearest Link-Belt office.



CONTINUOUS HOT STRIP MILL of Cleveland Works is equipped with this Link-Belt car-type conveyor, specially designed to promote cooling of coils along circuitous course from coilers to shipping area. The conveyor is approximately 1000 ft. long . . . travels around corners, up and down inclines.

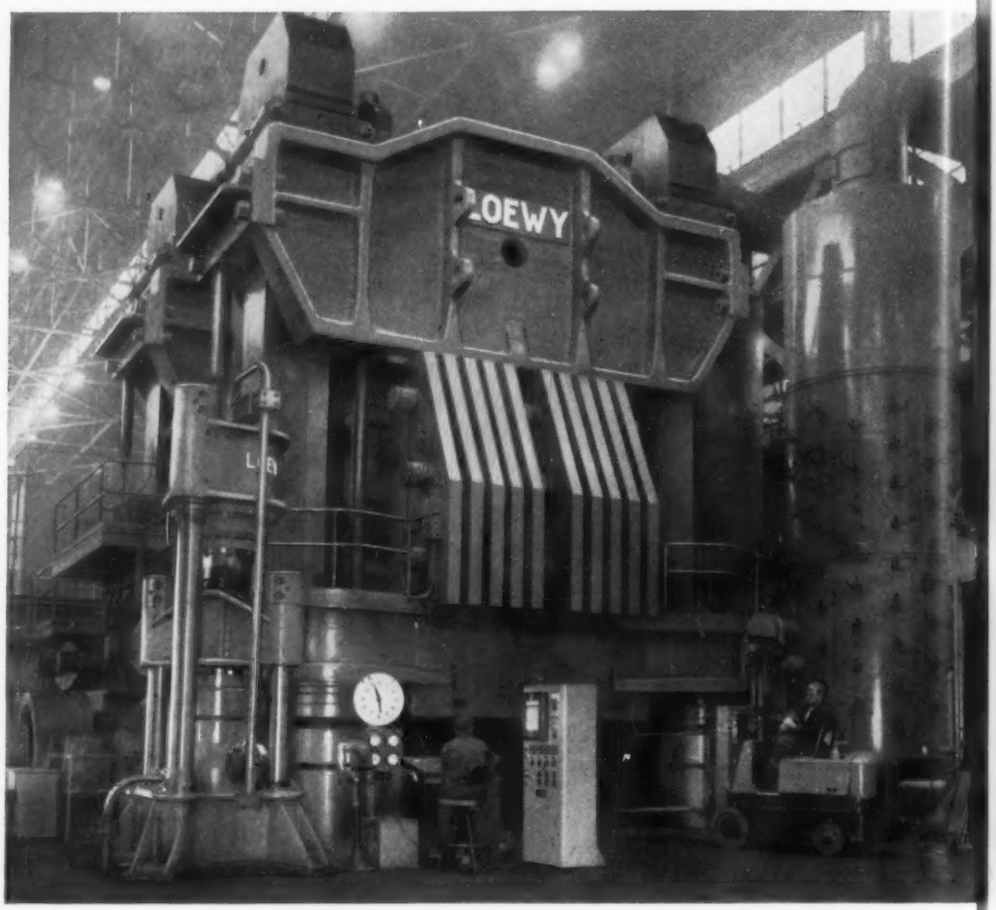
LINK-BELT

MATERIALS HANDLING, PROCESSING & POWER TRANSMISSION MACHINERY

LINK-BELT COMPANY: Executive Offices, Prudential Plaza, Chicago 1. To Serve Industry There Are Link-Belt Plants and Sales Offices in All Principal Cities. Export Office, New York 7; Australia, Marrickville (Sydney); Brazil, Sao Paulo; Canada, Scarboro (Toronto 13); South Africa, Springs. Representatives Throughout the World. 15.041

Can you automatically control speeds from 1/4 in./min. to 50 in./min. on your water-hydraulic press?

With Loewy's new automatic program speed control you can



One of the largest presses in existence, this closed die forging press designed and built by Loewy, and in operation at the Wyman Gordon plant, North Grafton, Mass., features automatic program speed control.

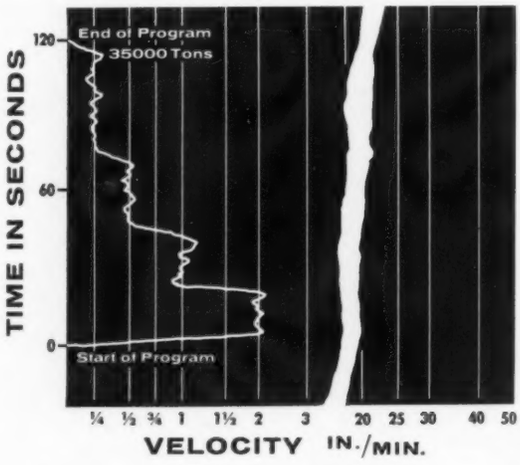
Structural and machine parts in aircraft, missiles and nuclear apparatus today demand greater strength and resistance to high temperatures, and many have extremely thin areas. Machining and other metal removing processes are not economical, due to the high cost of labor, waste of expensive alloy material, and loss of structural strength from cutting across the flow lines of metal. New metals, new methods and new equipment are needed for the economical production of parts that will consistently meet the severest requirements.

Regardless of which metal process is employed—extrusion, forging, die forging or deep drawing—the sound flow of material depends on so many variables that it becomes exceedingly difficult to coordinate them manually, especially in repeat performance. Excessively high speed may result in tears and uneven filling of die cavities. Unduly low speed may cause uneven cooling of material and, hence, interruption of the forming cycle.

To solve the problems of automatically controlling water-actuated hydraulic presses, Loewy-Hydropress had to bring to bear not only its resources in metallurgy and process engineering, but also its unique facilities in design of electronic controls.

The result is equipment which programs the change of speed and pressing force at preselected positions of the press stroke in existing installations. This makes it possible to translate experience in the production of high-quality metal parts into automatic repeat performance on any size hydraulic presses, including even the largest water-actuated presses, where such control was before unthinkable. Also it limits the maximum pressing force to a preset value and thus protects the tooling against overload.

For detailed information on the plastic forming of metals and on automatic controls for any machine process, write us today, Dept. C-2.



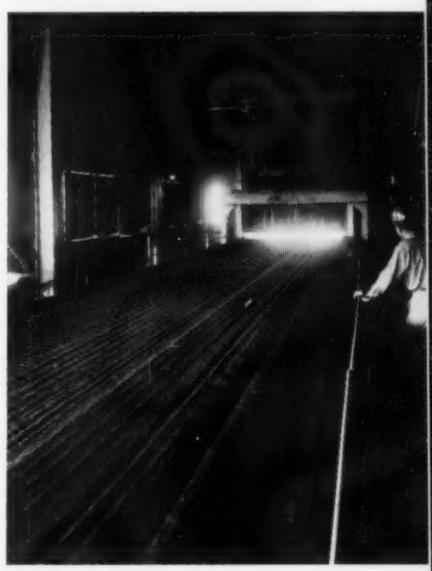
Graph shows a typical automatic control cycle consisting of four preselected speeds at preselected stroke positions up to 2 in./min. The workpiece is a 36-in. diameter steel billet. Pressure ranges from 6000 to 35,000 tons. Speeds range from ¼ in./min. to 2 in./min. and total pressing time is 2 minutes.

Loewy-Hydropress Division
BALDWIN · LIMA · HAMILTON
111 FIFTH AVENUE, NEW YORK 3, N.Y. Rolling mills • Hydraulic machinery • Industrial engineering

BALDWIN · BLH · LIMA-HAMILTON

There's a half-century of experience behind this

J&L SINTERING PLANT BY McKEE



THE plant below was completely designed and constructed by McKee to produce sinter for the Cleveland Works of Jones & Laughlin Steel Corporation.

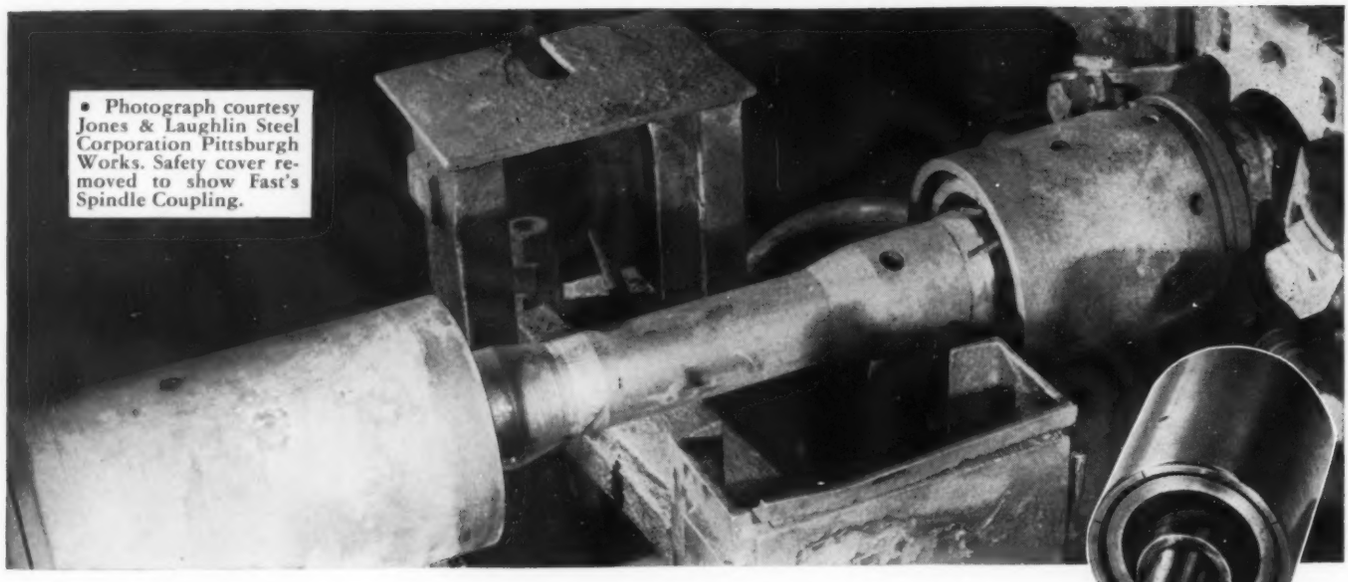
McKee's recognized leadership in the field of ore beneficiation is the result of an unmatched fund of knowledge and experience gained in serving the iron and steel industry since 1905. McKee designed and built almost all of the record-breaking blast furnaces in America. Today the company is contributing to new records with high-capacity sintering machines like that at right; plants employing advanced methods for pelletizing; new distributors and seals for high-speed, high-pressure operation; automatic charging controls and other modern blast furnace and steel plant facilities.

If you are planning future modernization or expansion it will pay you well to consult with McKee now on facilities for preparation of raw materials and production of iron and steel.

ARTHUR G. McKEE & COMPANY
2300 Chester Avenue, Cleveland 1, Ohio

McKEE ENGINEERING AND CONSTRUCTION SERVICES

OFFICES IN: CLEVELAND
NEW YORK • WASHINGTON
UNION, N.J. • HOUSTON, TEX.
TORONTO: ARTHUR G. McKEE & COMPANY OF CANADA, LTD.
ENGLAND: HEAD, WRIGHTSON & CO., LTD. (BRITISH REPRESENTATIVES OF METALS DIV.)



• Photograph courtesy Jones & Laughlin Steel Corporation Pittsburgh Works. Safety cover removed to show Fast's Spindle Coupling.

Fast's Spindle Couplings Mean More Profitable Rolling Mill Operations

★ *Up to 50% Less Down-Time*
★ *Quicker Disassembly*
★ *Bigger Savings on Maintenance*

The quick-disconnect and reliability features of Fast's Spindle Couplings may reduce down-time as much as 50%. Figured in dollars, this permits savings in production time in most rolling and blooming mill applications which can amount to thousands of dollars a month.

The new tooth configuration of Fast's Spindle Couplings compensates for a relatively high amount of misalignment with a minimum of backlash. It also permits constant angular velocity of the rolls which results in a marked improvement in the quality of the end product. Fast's Spindle Couplings are made of all steel construction with a metallic segmented conformable seal . . . completely self-contained and self-lubricated. They withstand the most rugged operating conditions, giving years of trouble-free service with only a minimum of maintenance.

Koppers' 38 years of experience in the coupling industry guarantees the right coupling engineered for a given application. To solve your rolling mill coupling problem write to KOPPERS COMPANY, INC., Fast's Coupling Department, 5002 Scott Street, Baltimore 3, Maryland.

Engineered Products
Sold with *Service*

KOPPERS

THE ORIGINAL
FAST'S Couplings

When I-T-E Circuit Breaker Company switched to an improved fabricating process in their Philadelphia plant, they needed a high-quality conductor to transmit the heavy current for the heating elements of a new electric furnace. But cost was the important consideration.

The problem was solved with Alcoa® Aluminum Bus Conductor. The cost was half that of copper, yet the electrical and heat dissipating characteristics were comparable.

Lightweight, corrosion-resistant Alcoa Aluminum Bus Conductor is accounting for similar savings among cost-conscious manufacturers in many industries. Initial cost is generally about half. Considerable savings in installation charges are common because the light weight of aluminum facilitates handling. Before you expand or modernize, check how much you can save with bus conductor of Alcoa Aluminum. Call Alcoa or your Alcoa Distributor. Aluminum Company of America, 2313-B Alcoa Building, Pittsburgh 19, Pa.

THESE DISTRIBUTORS OFFER IMMEDIATE DELIVERY OF ALCOA ALUMINUM BUS:

Brace-Mueller-Huntley, Inc.
Central Steel & Wire Co.
The Corey Steel Co.
Ducommun Metals & Supply Co.
Eastern Metals Warehouse, Inc.
Edgcomb Steel Co., Phila.
Edgcomb Steel of New England, Nashua
Hawkins Electric Company
Hinkle Supply Co., Inc.
Metal Goods Corp.
Pacific Metal Co.
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The J. M. Tull Metal & Supply Co., Inc.
Whitehead Metals, Inc.
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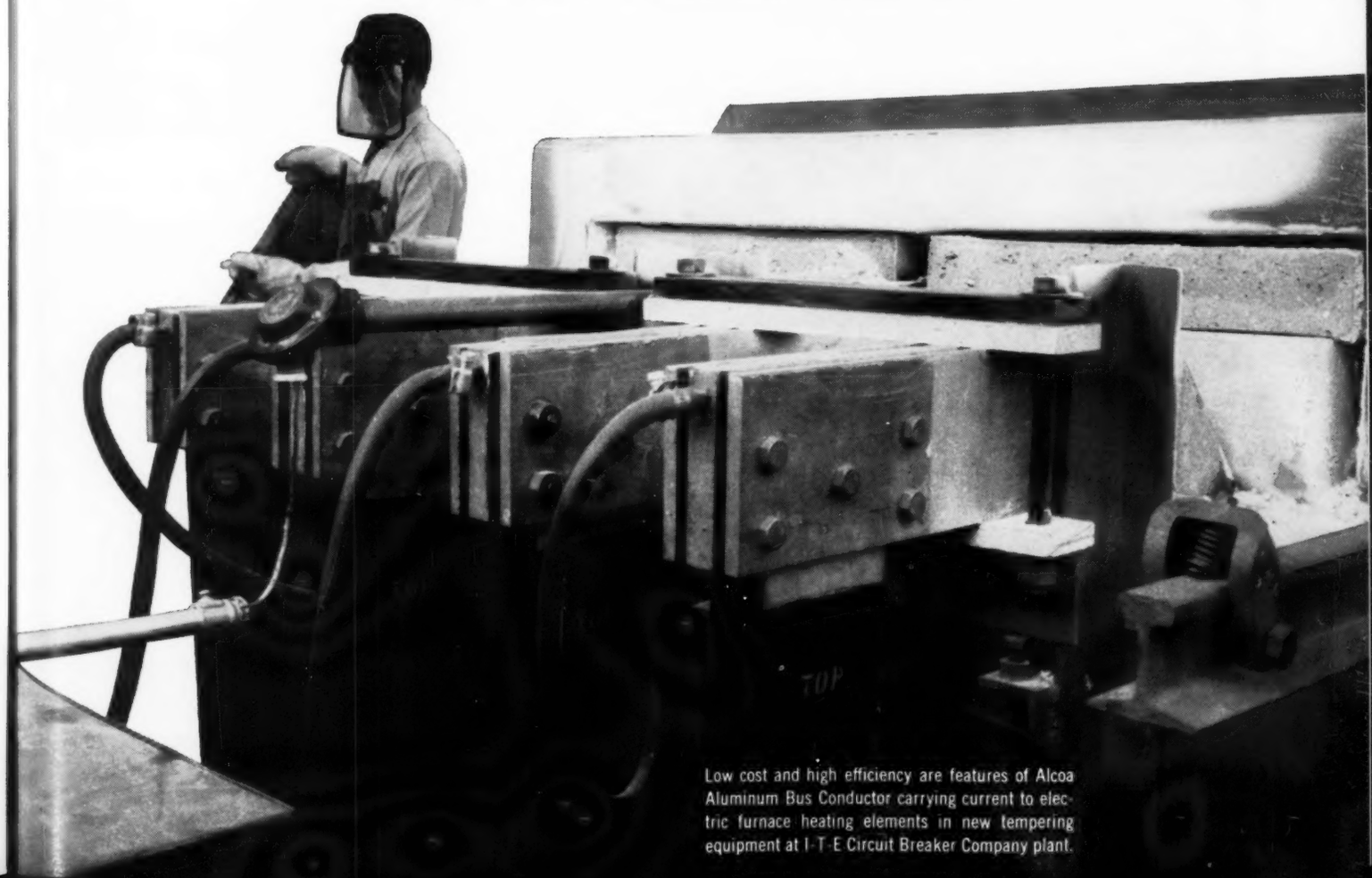
Your Guide to the Best in Aluminum Value

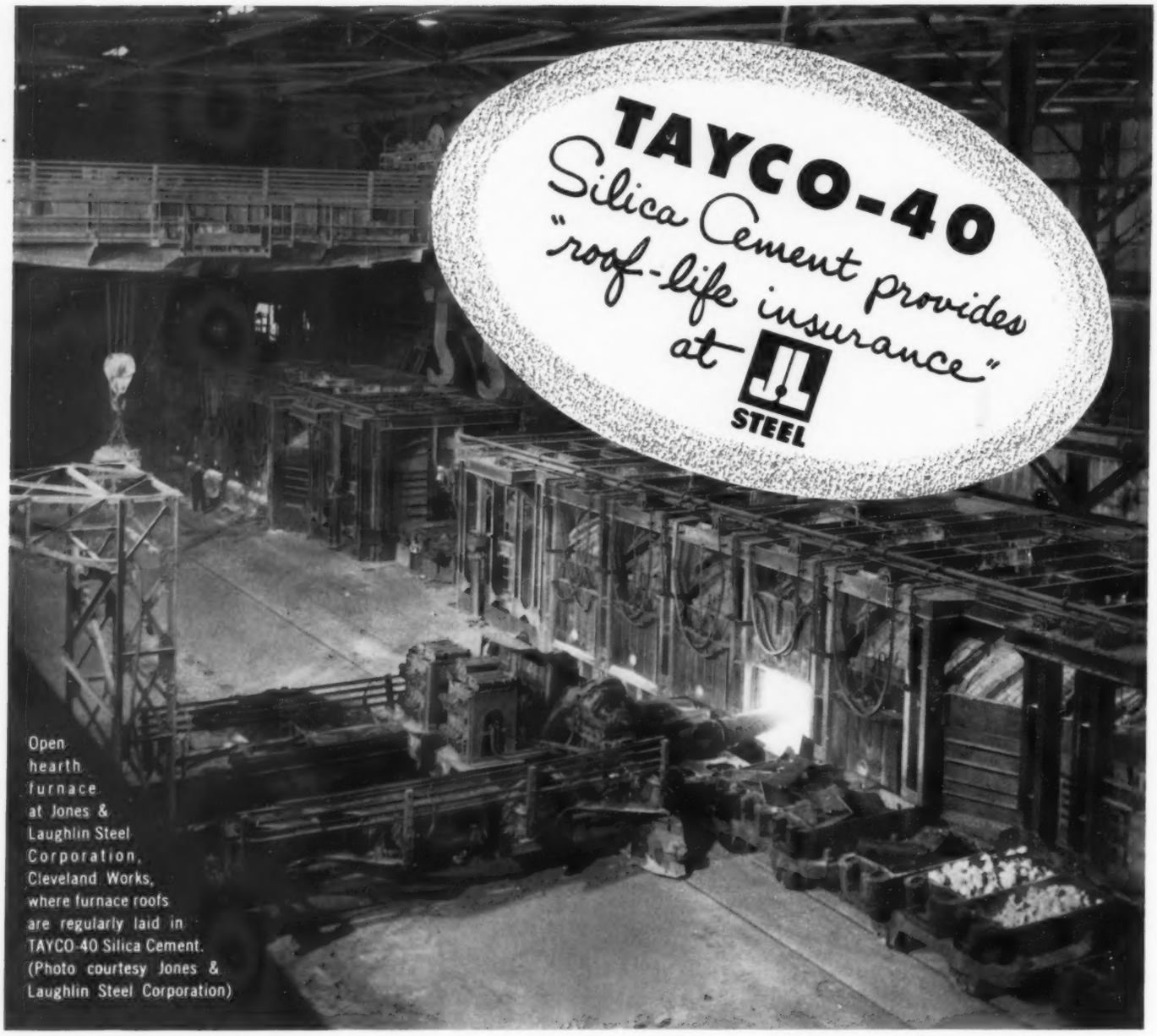
ALCOA ALUMINUM

For Exciting Drama Watch "Alcoa Theatre," Alternate Mondays, NBC-TV, and "Alcoa Presents," Every Tuesday, ABC-TV

ALCOA ALUMINUM BUS CONDUCTOR SAVES MONEY FOR I-T-E CIRCUIT BREAKER COMPANY



Low cost and high efficiency are features of Alcoa Aluminum Bus Conductor carrying current to electric furnace heating elements in new tempering equipment at I-T-E Circuit Breaker Company plant.



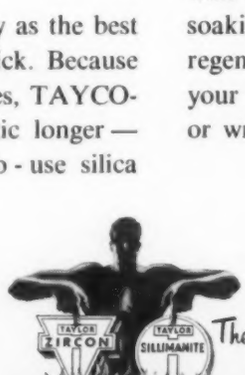
Open hearth furnace at Jones & Laughlin Steel Corporation, Cleveland Works, where furnace roofs are regularly laid in TAYCO-40 Silica Cement. (Photo courtesy Jones & Laughlin Steel Corporation)

At Jones & Laughlin Steel Corporation, Cleveland Works, as well as at other leading steel mills in the United States, TAYCO-40 Silica cement is regularly used to obtain tight, weld-like joints in silica open hearth furnace roofs.

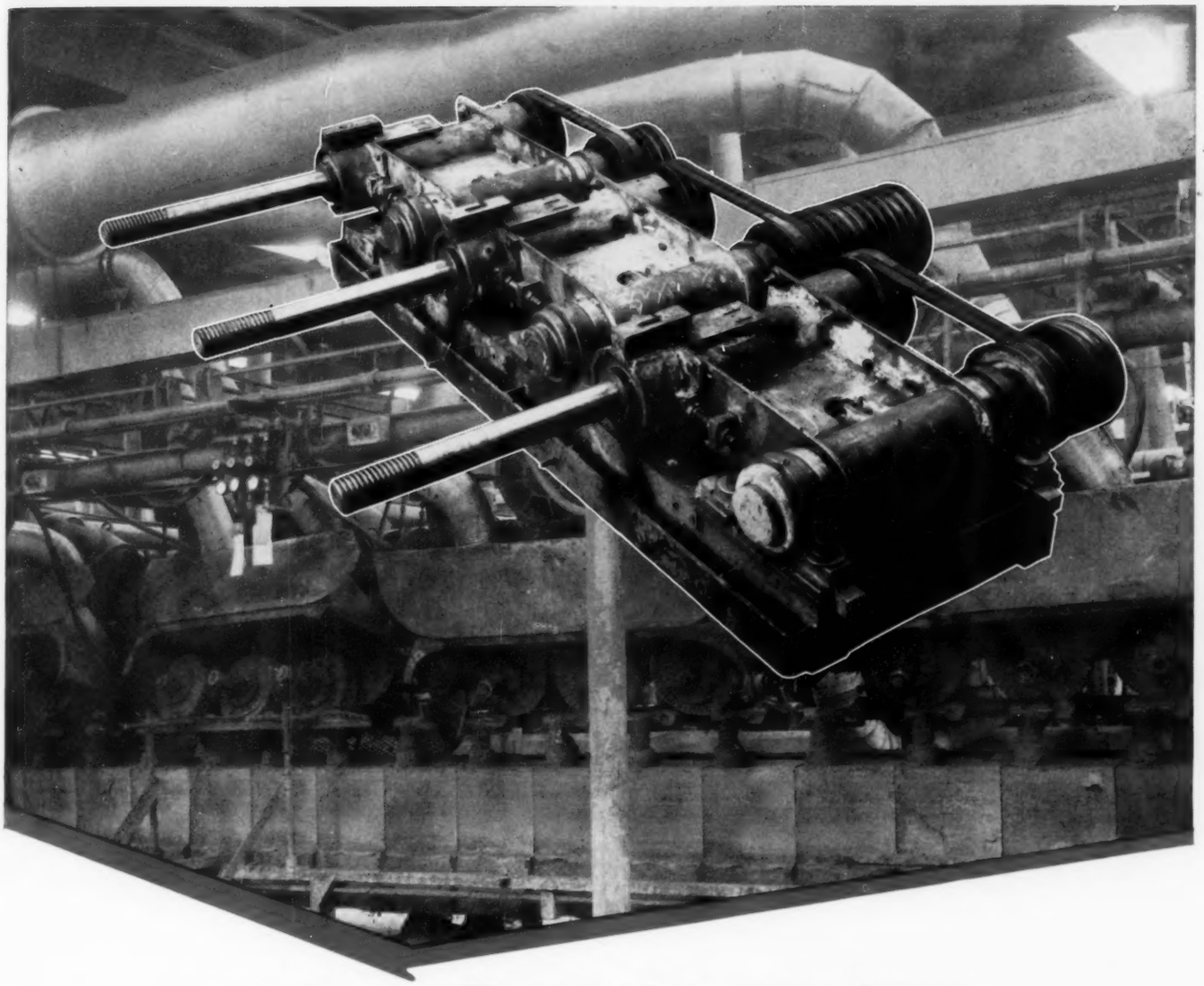
TAYCO-40 is nearly as refractory as the best grades of silica or super-duty silica brick. Because of its excellent water-retention properties, TAYCO-40 is smooth working — remains plastic longer — making it the most workable, easy-to-use silica cement available. These properties are obtained without the addition of plastic fire clays found in ordinary silica mortars.

TAYCO-40 is also highly recomended for use with silica and semi-silica brick and silica stone in soaking pits; with semi-silica brick in open-hearth regenerator walls and roofs. Try TAYCO-40 for your next rebuild. Ask your Taylor field engineer, or write direct, for full details.

Exclusive Agents in Canada:
REFRACTORIES ENGINEERING AND SUPPLIES, LTD.
Hamilton and Montreal



The **CHAS. TAYLOR SONS Co.**
A SUBSIDIARY OF NATIONAL LEAD COMPANY
REG. U. S. PAT. OFF.
REFRACTORIES SINCE 1864 • CINCINNATI • OHIO • U. S. A.



Here's a Bearings, Inc. idea that saved our customer $3,000 in labor, maintenance and parts in 7 months

Only an authorized bearing distributor such as Bearings, Inc., with the experience and facilities we have at our disposal, could have designed and supplied the special housings that hold the flinger sealed bearings that now have effectively solved this difficult bearing maintenance problem.

A well known automotive stamping plant designed and built this tandem buffing head (shown above) for its own use. Due to the extremely high concentration of metal dust from the buffing and polishing wheels conventional bearings had a very short life. Over 300 bearings were purchased in 7 months. Downtime due to bearing failure was very costly. The actual labor and material cost of replacing the bearings during this period exceeded $3,000! Since the new bearing units designed by Bearings, Inc. (shown enlarged) were installed, no bearing failures have occurred and no replacements have been installed.

Remember Bearings, Inc. when you need replacement bearings — Get "factory fresh" bearings of latest design and manufacture. We are *authorized* to sell most famous makes of bearings. We sell *only* those we are authorized to distribute. Call the Bearings, Inc. branch nearest you!

Providing bearing service in the North ➤ **BEARINGS, INC.**

OHIO: Akron • Canton • Cincinnati • Cleveland • Columbus • Dayton • Elyria • Hamilton • Lima • Lockland • Mansfield • Toledo • Youngstown • Zanesville
INDIANA: Ft. Wayne • Indianapolis • Muncie • Terre Haute • **PENNSYLVANIA:** Erie • Johnstown • Philadelphia • Pittsburgh • York
WEST VIRGINIA: Charleston • Huntington • Parkersburg • Wheeling • **NEW JERSEY:** Camden
NEW YORK: Buffalo, Balanrol Corp. • **MARYLAND:** Baltimore • **DELAWARE:** Wilmington

and

in the South ➤ **DIXIE BEARINGS, INC.**

FLORIDA: Jacksonville • **GEORGIA:** Atlanta • **KENTUCKY:** Louisville • **LOUISIANA:** Baton Rouge • New Orleans
N. CAROLINA: Charlotte • Greensboro • **S. CAROLINA:** Greenville • **TENNESSEE:** Chattanooga • Kingsport • Knoxville • Nashville

Designed to give you *Double Protection!*

WAGNER TYPE DP MOTORS

PROTECTED against corrosion...

PROTECTED against splashing liquids...

WM59-9

Wagner Type DP Motors provide *double protection* that means longer life—more versatility of application. Rugged cast iron frames and endplates are highly resistant to corrosion. Dripproof enclosures are so well designed that these motors can handle many applications that formerly required splashproof motors. These motors pack ample power into little space, are light in weight and are easy to maintain.

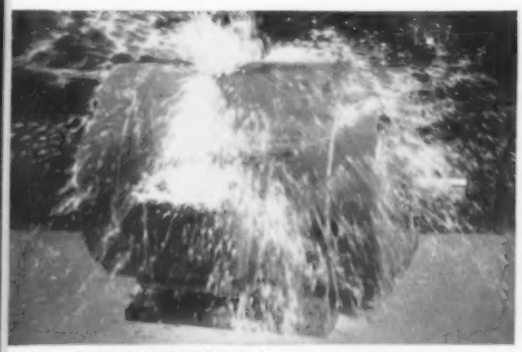
SLEEVE BEARING MODELS AVAILABLE. The entire line of ratings is available with ball bearing construction, or with steel-backed, babbitt-lined sleeve bearings of high load carrying capacity that provide quieter operation.

Let a Wagner Sales Engineer show you how these motors can be applied to your needs. Call the nearest branch office or write for Wagner Bulletin MU-223.

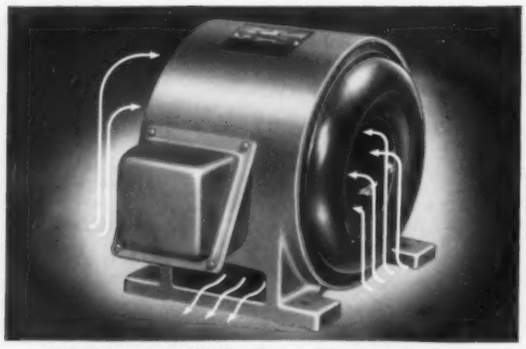
Branches and Distributors in All Principal Cities

Wagner Electric Corporation

6483 Plymouth Ave. • St. Louis 14, Missouri



DOUBLY PROTECTED—Air intakes and outlets are positioned to provide complete protection against dripping or splashing liquids. Rugged cast iron frames protect against rough handling and corrosion.



COOLING RUNNING—Specially designed baffles, which protect the stator windings, direct a cooling stream of air through the motor to effectively cool the motor—add to motor life.

CAN BE RE-LUBRICATED—Original factory lubrication will last for years in normal service—but grease plugs are provided to permit re-lubrication that adds years to motor life under severe conditions.

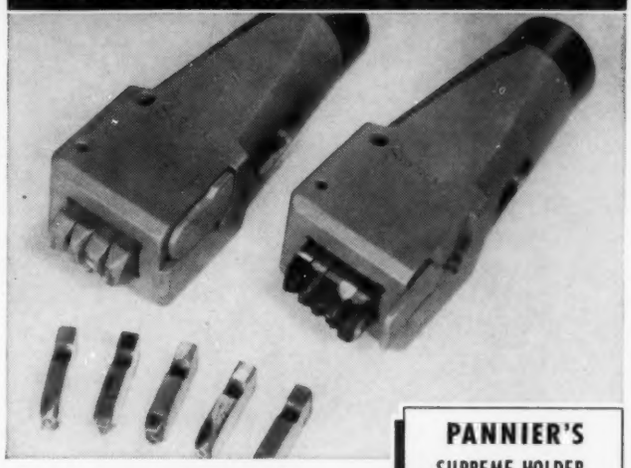
Metal Cutting Knives *ONLY*

We offer forty years of experience in producing the highest quality Metal Cutting Knives and skilled craftsmen working with the finest materials to exacting tolerances.

A bulletin on "Metal Shearing Aids" will be sent on request.

THE HILL ACME COMPANY
CLEVELAND KNIFE DIVISION
1201 West 65th St. • Cleveland 2, Ohio

ANOTHER *PANNIER* MASTER MARKER!



New Roto-Pin type lock is integral part of *all* Pannier Supreme Holders . . . eliminates loose, bent, dropped, or lost pins . . . flip it open to change type . . . flip it back to securely lock type in clear-marking position.

PANNIER'S SUPREME HOLDER WITH ROTO-PIN LOCK

Safe, fast type changing. Holder in variety of styles. Machined from High-Grade Bar Tool Steel. Hardened anvil maintains type alignment. Striking Head of Tool Steel . . . Replaceable to add long service life to Holder.

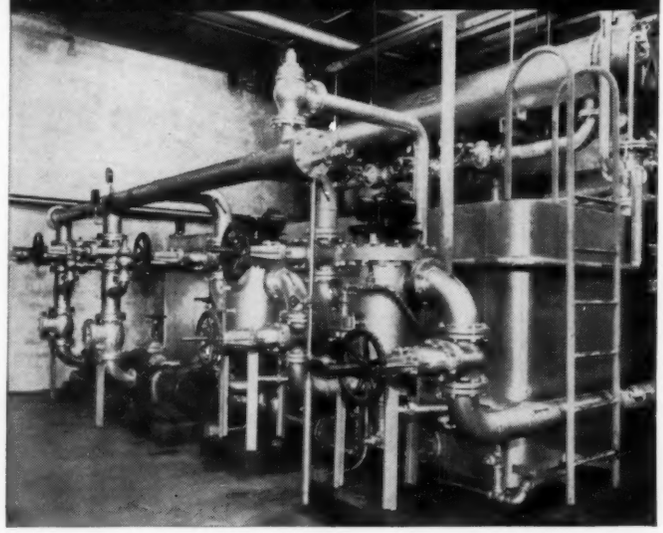
Write for complete data.

BIRTHMARKED MATERIALS

MARKING DEVICES
THE PANNIER CORPORATION
302 Pannier Building • FAirfax 1-5185 • Pittsburgh 12, Pa.
Offices: Los Angeles • Chicago • Cleveland • Philadelphia • Birmingham

DRAVO-DELAVAL lubrication and coolant systems

Engineered Protection for Rolling Mill Machinery



Dravo-DeLaval Lubrication and Coolant systems are designed to circulate the right amount of lubricant at the right pressure and temperature to the right spot. Dravo Lubrication systems include these four fundamentals essential to efficient mill lubrication:

Streamline Flow

Piping, elbows and valves are carefully selected to hold pressure drops to a minimum and to provide non-turbulent flow.

Correct Metering of Lubricant

Dravo systems are designed to supply the right amount of lubricant needed at each lubrication point.

Temperature Control

Accurate, automatic temperature control is a feature of every Dravo system.

Efficient Filtering

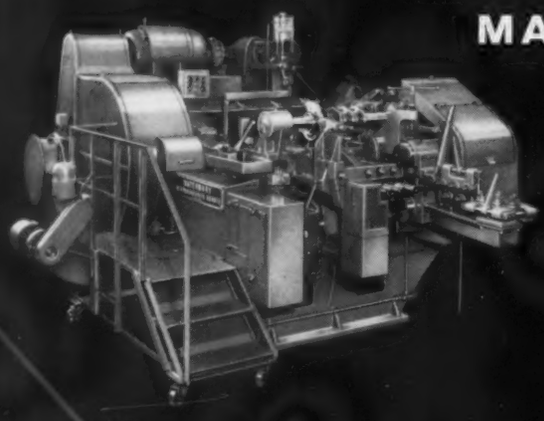
Full flow, pressure type filters allow an uninterrupted flow of clean lubricant with minimum pressure drop.

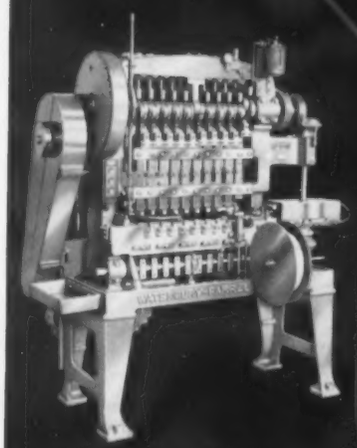
Dravo-DeLaval systems are custom designed to match customer requirements. For installations requiring up to 50 gpm, Dravo-DeLaval Unilube units offer compact, economical "packaged" lubrication systems. For complete details, write Dravo Corporation, Dravo Building, Pittsburgh 22, Pennsylvania.

DRAVO
CORPORATION

Special Lubrication and Coolant Systems for mechanical equipment serving industry

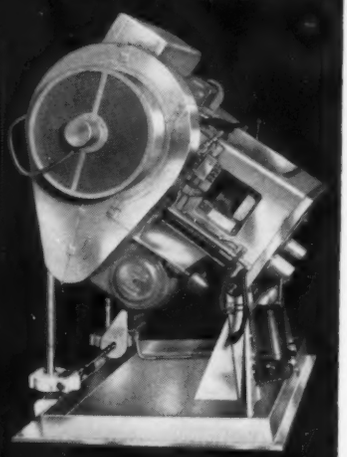
COLD HEADING
MACHINERY



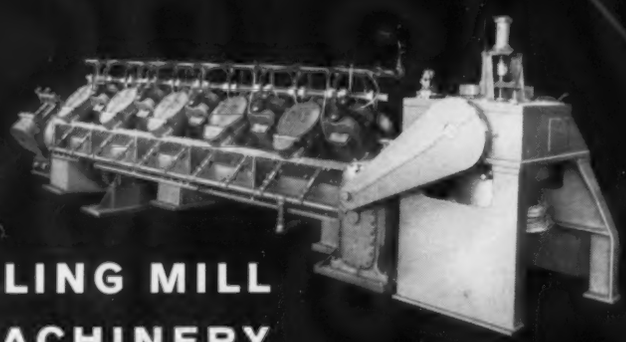


WATERBURY
MACHINERY BUILDERS
FARREL

POWER
PRESSES



EYELET,
SLITTER
& WIRE
MACHINERY



ROLLING MILL
MACHINERY

THE WATERBURY FARREL FOUNDRY & MACHINE CO.
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WF-55

Sharp eyes follow the progress of Bethlehem Rolls

Checking every detail is more than a routine habit in the making of Bethlehem forged rolls. It's done with extra thoroughness, extra care—from the early analysis of the steel to the critical inspection of the finished product.

The customer can be confident that his specifications on hardness, dimensions, and finish will always be met in full. Bethlehem never releases a roll until every technician on the job has been thoroughly satisfied.

Bethlehem forged rolls are made in every size—for every application. They are widely used in cold-rolling ferrous sheets and strip . . . running-down and finishing operations on copper and brass sheets . . . hot- and cold-rolling aluminum sheets . . . cold-rolling aluminum foil. Call us for details; we can always meet your needs.

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.

On the Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast Steel Corporation. *Export Distributor:* Bethlehem Steel Export Corporation

BETHLEHEM STEEL

BETHLEHEM STEEL

POST-GLOVER RESISTORS...

Racked to suit the application!

P-G the ORIGINAL Steel Grid Resistor

Made of steel and mica, nothing to break, plus P-G unique and exclusive grid design, these resistors afford maximum protection to vital equipment. They are rugged, nonbreakable, shock resistant, and have proved their merit in all kinds of service for over 20 years.

Plain Racks without enclosure

Racks with solid or expanded metal tops

Racks with louvered or expanded metal sides

P-G Resistor Racks are available for all P-G Resistors in units from two to eight resistors high. If other than standard racks are more suitable, special racks can be furnished to suit the application. Ventilation is achieved through louvered or expanded metal panels as desired, both easily removable with only a screw driver. P-G Racks may be shipped complete with resistors mounted, with or without enclosure, or knocked down to save shipping space. For further data about P-G Resistors and Racks, write us of your needs.

The Nonbreakable Steel Grid Resistor

P-G

ESTABLISHED 1892

THE **POST-GLOVER** ELECTRIC COMPANY

OFFICE and FACTORY—**Kenton Lands Road, Erlanger, Kentucky**

MAILING ADDRESS—**Box 709, Covington, Kentucky**

"Well Done, thy Good and Faithful Servant!"

In this case, Special Super RAMTITE 25

Regenerative Soaking Pit—approximately 14′ long by 7½′ wide. Wall is of Ramtite No. 25, installed in August, 1957. Note excellent condition.

Recuperative Soaking Pit—approximately 27′ long and 9½′ high. Division wall has withstood fire on both sides since installation in October, 1957. Note excellent condition.

Two Jones & Laughlin Installations [CLEVELAND PLANT]

THAT HAVE RESISTED THE HEAT

While taking a tour of the Jones & Laughlin mill from your easy chair, look above to your left, a regenerative soaking pit, and to your right—a recuperative soaking pit.

The common denominators: both are RAMTITE installations (*Special Super Ramtite No. 25*)—both were installed in 1957 and both are still in excellent condition.

These are the oldest of numerous RAMTITE installations at the J & L mills and the unretouched photos show how they stand the gaff of heat and time.

Let RAMTITE serve you faithfully under fire, too!

RAMTITE, as the name implies, is a plastic refractory that is rammed into place to form a homogeneous mass which hardens like steel. Being monolithic, it is air-tight, gas-tight and flame-tight, allowing for no air infiltration. Installed under direction of RAMTITE supervisors.

Send for "Steel Plant Furnace Construction." Have you any questions about RAMTITE?

The Ramtite Co.

DIV. OF THE S. OBERMAYER CO.

1813 South Rockwell St. Chicago 8, Ill.

TRABON

CENTRALIZED LUBRICATING SYSTEMS

Giant ore bridge buckets dig and load 17% more with Trabon lubrication

Now, lubricating this giant ore bridge bucket is simple and economical! All a man does is to connect a very inexpensive grease gun to a Trabon heavy duty feeder. All 40 bearings then receive the exact measured amount of grease they need in a matter of minutes. Downtime for lubrication is cut from 45 minutes to less than 5 minutes. Digging and blast furnace loading time is increased 17% each 8-hour day. Lubrication is now safe, dependable and positive since Trabon Centralized Lubrication Systems were installed at this Midwestern steel plant three years ago on three giant ore bridge buckets. Write today for further information.

Close up shows Trabon feeder system operating on one of three similarly equipped ore bridge buckets. All industry relies on Trabon for positive lubrication under rugged conditions.

Trabon

Trabon Engineering Corporation

28785 Aurora Road • Solon, Ohio

Centralized OIL AND GREASE SYSTEMS *Metroliff* CIRCULATING OIL SYSTEMS

Equipment News...

GAS CIRCUIT BREAKER

Δ The first 230-kv, 15,000-MVA sulphur hexafluoride circuit breaker designed and built by the Westinghouse Electric Corp. will be installed on the Pennsylvania Power and Light Co.'s system in mid-1960.

The unusual arc-interrupting ability of sulphur hexafluoride gas has made it possible to design a large high-voltage, high-power circuit breaker that combines the best features of insulating oil and compressed air designs. From oil breaker designs, the new breaker has borrowed dead-tank construction, positive mechanical connection between all contacts and operating mechanisms, and bushing-type current transformers.

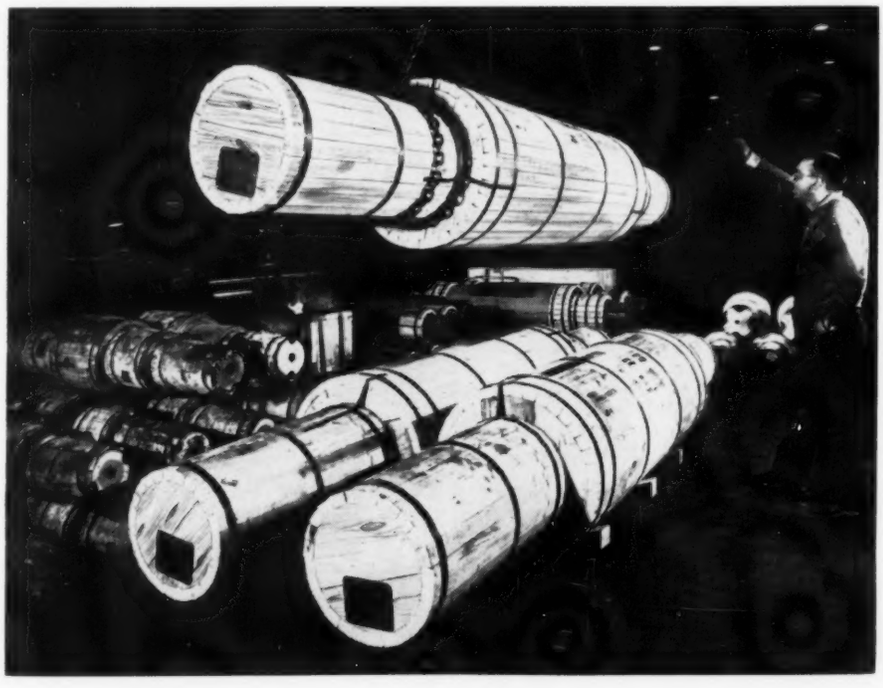
Like air breakers, the SF_6 breaker has light weight, low-impact loading of foundations, and consequently light foundation requirements. Since the unit is self-contained and does not exhaust to atmosphere, the breaker does not make the noise of an air breaker. Also, the auxiliary apparatus normally required with air breakers has been held to a minimum.

Basically, each pole of the breaker consists of a round horizontal tank, with a bushing rising vertically from each end, and the interrupter mounted axially within the tank between bushings. Minimum dimensions are made possible by the high dielectric properties of sulphur hexafluoride. The gas readily recombines after arc extinction, resulting in negligible gas decomposition and extending time between maintenance periods.

Being a ground-level tank, platforms are not required during installation and service work on the breaker. The interrupter consists of multiple-break contacts tied together mechanically to a single operator, assuring simultaneous making and breaking of contacts.

PACKAGING SAFEGUARDS ROLLS SHIPPED ABROAD

Cast and machined at the Warwood, W. Va., foundry of Blaw-Knox Co., these finished iron rolls, are ready for shipment abroad. First step in the packaging operation is the application of grease to guard the rolls against the corrosive effects of salt atmosphere. Then comes a wrapping of thin nonacid paper, covered with a layer of waterproof paper. This covering is held in place by steel strapping $\frac{1}{32}$ in. thick and $\frac{3}{4}$ in. wide. Next, the rolls are enclosed in wood lagging, tapered to follow the contour of the roll and fit snug. Steel bands, identical to those used to hold the paper coverings in place, secure the lagging. Fitting the lagging to the contour of the rolls makes them easier to handle and reduces shipping space requirements.



STRAIGHTENERS

Δ Sutton Engineering Co. has announced a complete new series of 5-roll, rotary bar and tube straighteners equipped with patented Syncro-Drive. Users now can straighten materials otherwise difficult, or even impossible to straighten, such as thin-walled tubes and bars of stainless steel, brass, zirconium, titanium and other modern metals.

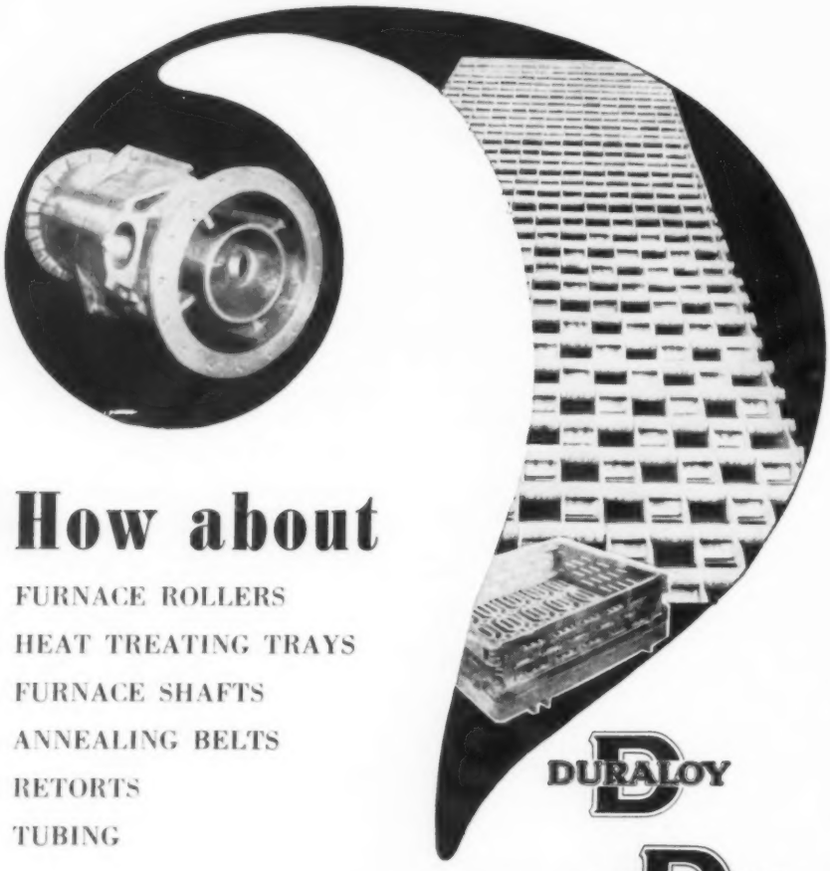
Syncro-Drive now is available in all sizes for tubes from $\frac{1}{16}$ in. to 6 in. O.D. and bars from $\frac{1}{16}$ in. to 4 in. diam. in all metals. Each size machine straightens a wide range of tube and bar sizes.

In the 5-roll Syncro-Drive design, three small pressure rolls are opposed by two large straightening rolls. All five rolls are driven by a single motor, with the Syncro-Drive mounted between the drives for the two banks of opposed rolls. Feeding is easy and positive. Surface speeds of each bank of rolls are co-ordinated automatically, compensating for roll wear and differences in angular roll setting. Less re-dressing is required for maximum roll life.

All 5-roll straighteners feature quick setup and change over, power operated screw-downs for larger machines, simplified roll angle adjustment with positive lock, open-frame construction for fast roll change, pneumatically counter-balanced vertical rolls, and excellent operator visibility. In addition to 5-roll machines, Sutton 2-roll straighteners also are available with Syncro-Drive for precision straightening or straightening and polishing metal bars.

THERMOCOUPLE TUBES

Δ The first production of entirely clear immersion thermocouple protection tubes has been announced by



How about

FURNACE ROLLERS

HEAT TREATING TRAYS

FURNACE SHAFTS

ANNEALING BELTS

RETORTS

TUBING

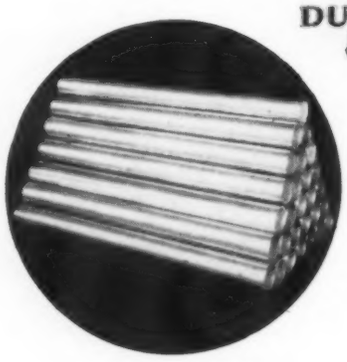
DURALOY

DURASPUN

Which are
Heat Resistant

Corrosion Resistant

Abrasion Resistant



When ready to order, how about checking with us here at DURALOY? For more than thirty years we have specialized in high-alloy castings. In fact, we were among the first to produce static castings and the first to produce centrifugal castings. We are old hands at producing castings alloyed to fit each specific requirement and to finish them to any extent desired.

Melt, castings and finishing are carefully controlled and quality tested by our staff of metallurgists, chemists, X-ray and gamma ray technicians. If you would like more preliminary information, send for Bulletin No. 3150-G.

The DURALOY Company

OFFICE AND PLANT: Scottdale, Pa.

EASTERN OFFICE: 12 East 41st Street, New York 17, N. Y.
ATLANTA OFFICE: 76—4th Street, N.W.
CHICAGO OFFICE: 332 South Michigan Avenue
DETROIT OFFICE: 23906 Woodward Avenue, Pleasant Ridge, Mich.

Charles Engelhard, Inc., an associated company of Engelhard Industries, Inc.

The new tubes are completely transparent from end to end and thus enable the users of thermocouples to accurately emplace in them the platinum tips of the heat-measuring devices prior to their insertion in molten metal.

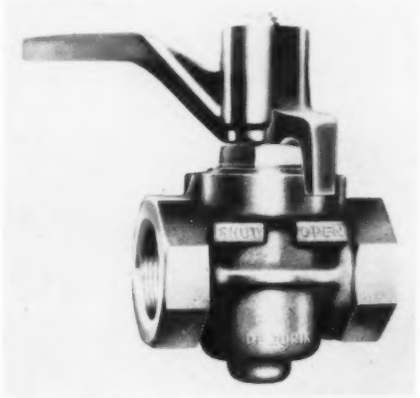
Other types of thermocouple tubes are translucent except for a clear half-inch at the sealed ends or have opaque tips.

Made of clear quartz, the newly produced tubes have outside diameters of seven-and-a-half to eight millimeters and their lengths are specified by order. They are impervious to temperatures well above 2500 F.

VACUUM VALVE

△ The DeZurik Corp. has announced release of a new line of vacuum valves based on a design which is a radical departure from vacuum valves presently on the market.

The valve design is based on a unique and exclusive eccentric prin-

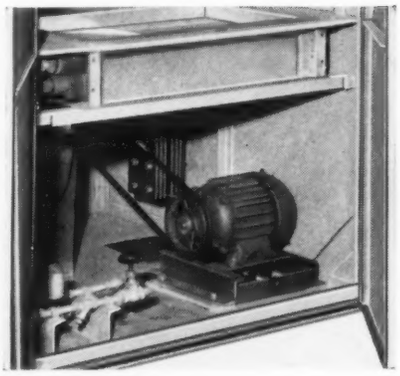


ciple. The plug, eccentric, or cam-shaped in cross section, matches an eccentrically-raised body seat. Carried on journals at either end, the plug rotates only a quarter-turn from full open to dead shut. The plug face and seat are in contact only when the valve is closed; in opening the valve, the slightest rotation of the plug breaks the contact, and the valve action is free, easy and frictionless.

Tight shut-off is achieved by the eccentric action in combination with a resilient facing on the plug. The leak rate across the seat on a 3-in. valve is certified at less than 0.003 micron cu ft per hr. Certified stem leak rate on valves 3-in. and smaller is 0.01 micron cu ft per hr. Each

SEMI-CONDUCTOR RECTIFIER

Two 100-kw, 250-volt silicon rectifiers installed in industrial service. Semi-conductor rectifiers are simple in operation and maintenance, require little floor space.



Effective cooling — closed recirculating air system features air-to-water heat exchange and delivers same amount of cooling air to each diode. Air is sealed in. Direct air cooling system also available.

Only application experience like this can give you highest conversion efficiency

High power conversion efficiency at low cost is the major advantage of the semi-conductor rectifier. But this high efficiency — as high as 95% — can be obtained only when the unit is *correctly applied*.

Allis-Chalmers 30 years of experience in developing, manufacturing and *applying* rectifiers assures you of the highest conversion efficiency. This background of experience, plus vast research and engineering facilities, is available for a thorough analysis of your requirements. Then, specific, unbiased equipment recommendations are made — dictated solely by your requirements — because Allis-Chalmers makes all types of rectifiers.

Every semi-conductor rectifier installed by Allis-Chalmers has performed to the complete satisfaction of the user. Your local A-C man can tell you how a semi-conductor rectifier can be applied profitably to your operations. Call him. Or write Allis-Chalmers, Industrial Equipment Division, Milwaukee 1, Wisconsin.

Plan to stay ahead... MODERNIZE!

A-C ALLIS-CHALMERS

ALLIS-CHALMERS

A-5817

SUCCESS STORIES!

BLAST FURNACE. One of the largest steel companies uses Super #3000 for 75% of all blast furnace relining, including carbon brick.

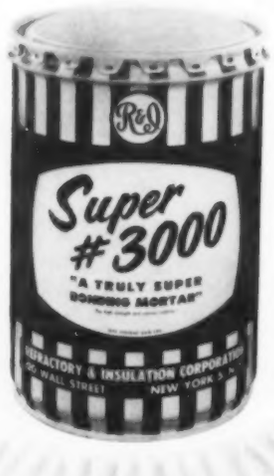
SUBMARINE LADLES. Pittsburgh steel mill reports that Super #3000 has increased life of submarine ladle lining 20%. Service is severe. Considerable "hold time." Lining used constantly without repair until relining.

STOPPER RODS. Previously, joint between ceramic sleeve and graphite head was filled with special mortar. However, steel cut through joint and stuck to rod. Had to be ground or burned off. Super #3000 was tried in joint (2 lbs. per rod). No trouble since.

OPEN HEARTH SLAG POCKET. Because of extremely high temperature, the suspended arch over the open hearth slag pocket required a 60% alumina brick and super duty mortar.

Previous experience indicated need for a better mortar. Super #3000 was tried.

After 288 heats, the arch was still in good condition. No mortar squeezing from joints. No deterioration of brick at joints due to bad bonding.



REFRACTORY & INSULATION CORP.

REFRACTORY BONDING AND CASTABLE CEMENTS
INSULATING BLOCK, BLANKETS AND CEMENTS

136 WALL ST., NEW YORK 5, N. Y.

valve destined for high vacuum application is certified by a seat and stem seal test on a helium mass spectrometer type leak detector.

Straight thru flow and a large port area assure low impedance, so necessary in high vacuum services.

Valves are available in semi-steel, stainless steel, ni-resist, bronze, acid resisting bronze, steel, aluminum, Alloy 20, monel, pure nickel, Hastelloy B, Hastelloy C and other alloys; they are manufactured in sizes ½ in. thru 20 in.; they can be supplied for manual operation or with on-off or positioning type actuators for automatic and remote control.

PUMPING MOTOR

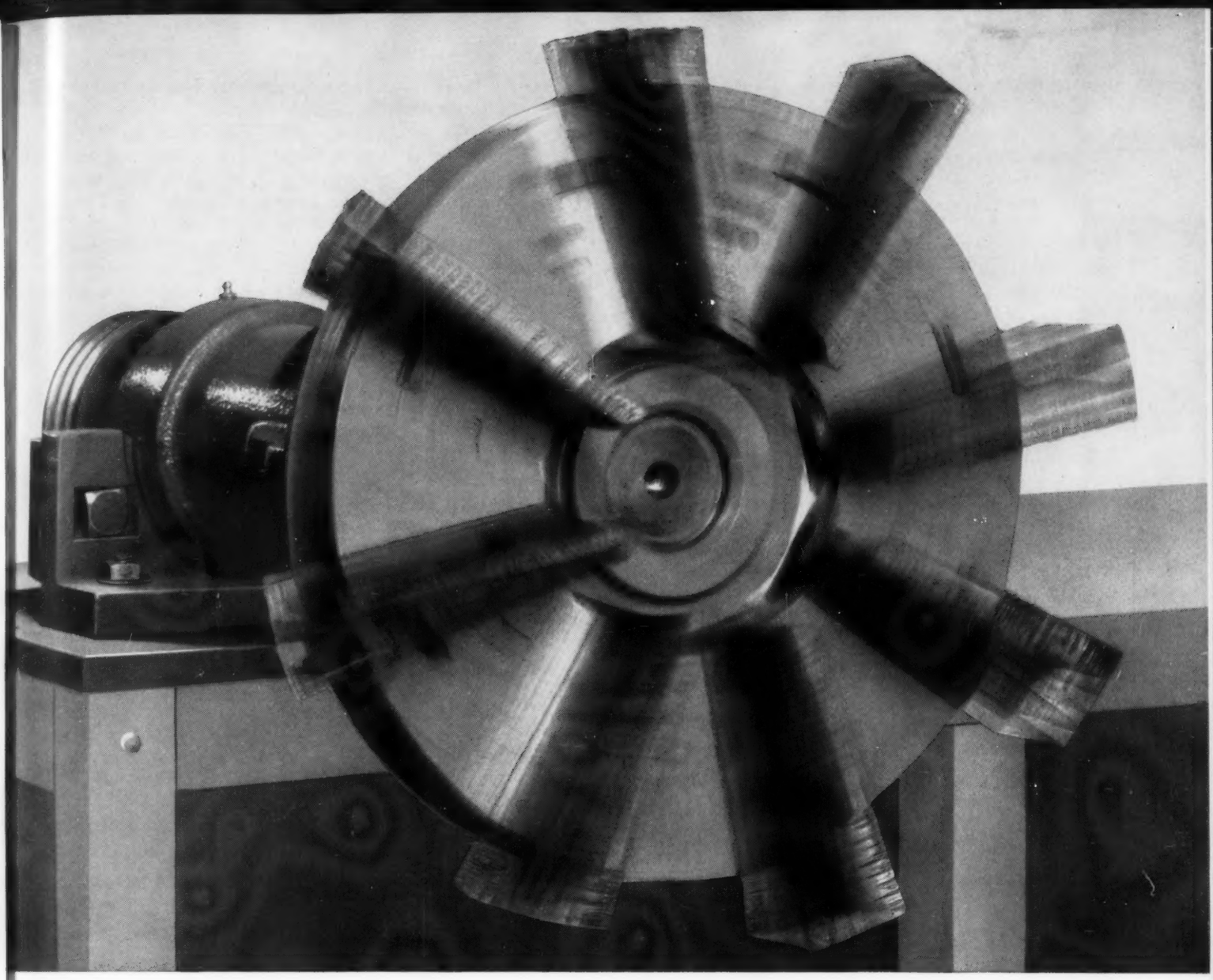
△ A new re-rated vertical motor, designed for easier installation and maintenance in industrial pumping applications, is now available from General Electric Co.

The addition of this totally-enclosed, fan-cooled, explosion-proof motor gives GE a complete line of vertical motors in the new NEMA re-rated frame sizes.

New design features of the motor

COAL BUCKET

Clean-up operations are handled by this eight-ton capacity coal clean-up bucket at the Indiana Harbor Plant of Inland Steel Co. The Blaw-Knox Size GC-3202 bucket is a four-rope geared hinge direct reeved bridge type unit that has been in service 18 months. Weighing approximately 31,900 lb, the bucket has an open spread of 20 ft and a width of 12 ft, assuring a deck coverage clean-up area of 240 sq ft at each pass. Shown in a 7½-ft long closed position, the unit passes through a 9-ft wide hatch opening.

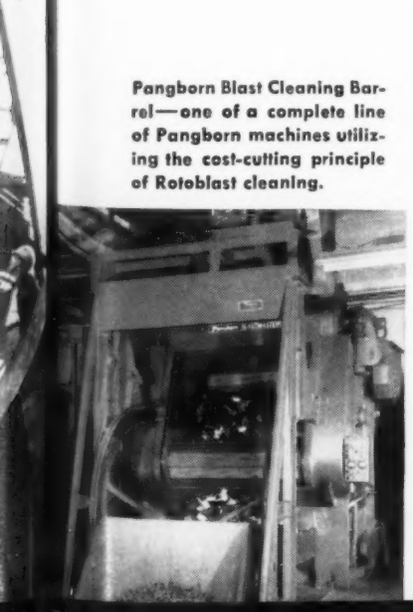


"Rotoblasting" a profit pattern

Pangborn Rotoblast Wheel gives you minimum blast cleaning costs.

This cutaway view of power-in-motion spells *efficiency* . . . the efficiency of Pangborn Blast Cleaning Machines.

The Pangborn-developed central impellor design makes possible high abrasive discharging capacity at high efficiency. Up to 160,000 lbs. of abrasive an hour can be efficiently handled by these Rotoblast Wheels. Service ease and reliability are assured by Pangborn vane locking design. Permanent factory alignment of running parts and bearings, plus the lubrication system, permit wheel spindle mounting at any angle. It is this kind of engineering—whichever size Rotoblast Wheel *your* Blast Cleaning Machine needs—that lowers cost by giving you maximum production with a minimum of maintenance.



Pangborn Blast Cleaning Barrel—one of a complete line of Pangborn machines utilizing the cost-cutting principle of Rotoblast cleaning.

The Pangborn Engineer in your area will be glad to go to work on your cleaning problem at no obligation. And for complete information on Pangborn Rotoblast Wheels, write to Pangborn Corp., *4400 Pangborn Blvd., Hagerstown, Md., Manufacturers of Blast Cleaning and Dust Control Equipment.*

Pangborn cleans it fast with ROTOBLAST®

allowing easier maintenance include oversize oil filler hole, large drain plug, easy access conduit box, oil level sight gage and a light weight top cap. Handy lifting lungs aid in installation.

The motor runs through the 445 UP frame size. The full line now has ratings available from 7½ to 125 hp at 1800 rpm. Alternate bases are available to fill requirements for most units with the superceded NEMA base dimensions.

CARBON LINING

△ Great Lakes Steel Corp., Division of National Steel Corp., has installed some 45,000 carbon brick weighing nearly 700,000 lb in rebuilding and redesigning its "D" blast furnace. The carbon lining increases the hearth diameter to 29½ ft from the 28-ft diam possible with a thicker ceramic lining, and results in greater capacity for the production of high quality pig iron.

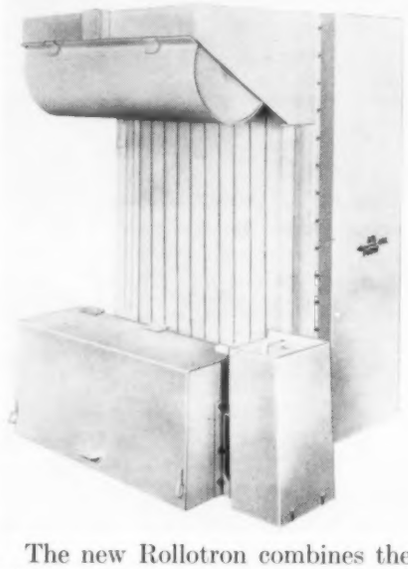
The carbon brick was manufactured by National Carbon Co., Division of Union Carbide Corp., at its new Lawrenceburg, Tenn., plant. In production since late 1957, the plant was designed around a revolutionary new process that simultaneously forms and bakes carbon products, reducing process time from as long as eight weeks to less than eight minutes.

The carbon hearthwall in "D" blast furnace is 27 in. thick and approximately 15 ft high. The next section, the tuyere breast, is 18 in. thick and nearly 7 ft high. The upper section of the lining, the bosh, is 15 in. thick and almost 13 ft high, with the individual bricks tapered on the ends to fit the bosh slope of some 6 deg from the vertical.

Two other blast furnaces operated by the corporation have carbon hearth linings, with one now on its second carbon hearth lining. Successful experience with carbon as a refractory material prompted Great Lakes Steel to choose the new NMA grade made by National Carbon Co. in an attempt to get the longest possible campaign with one lining, with a resultant minimum hot-metal cost.

AUTOMATIC FILTER

△ The American Air Filter Co. announces the Type B Rollotron which is a new design of the basic Rollotron agglomerator-filter principle introduced by AAF.



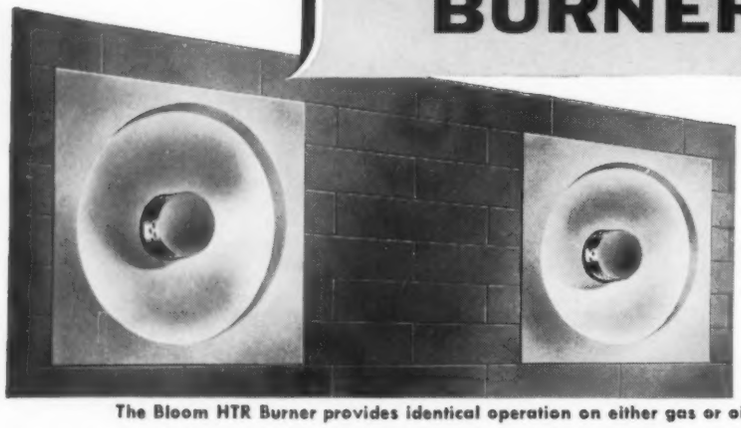
The new Rollotron combines the high efficiency of an electronic precipitator with the low maintenance of an automatic, renewable media filter.

In the unit, dry electrostatically charged plates are used to agglomerate atmospheric contaminates—such as dirt, bacteria, pollen, smoke, etc. The agglomerated particles (including submicron sizes) are held together by intermolecular attraction until they are picked up by the air stream and deposited in the renew-

(*Please turn to page 235*)

for intense concentration of heat...

The BLOOM HTR BURNER



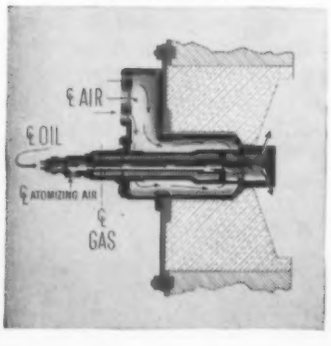
The Bloom HTR Burner provides identical operation on either gas or oil.

This burner enables the engineer to design a heat pattern with excellent results, because it has the unique characteristic of providing localized high heat release with low forward velocity. The burner can be located to fire directly at the material without flame impingement. Roof firing is easily accomplished and provides uniform hearth temperature.

This burner has been very successful in its application to tube upset furnaces; continuous strip annealing, coating, and pre-heating lines; high speed billet heating furnaces; and batch-type forge furnaces.

The Bloom High Thermal Release Burner with its sturdy construction is ideal for applications requiring speed and precision heating.

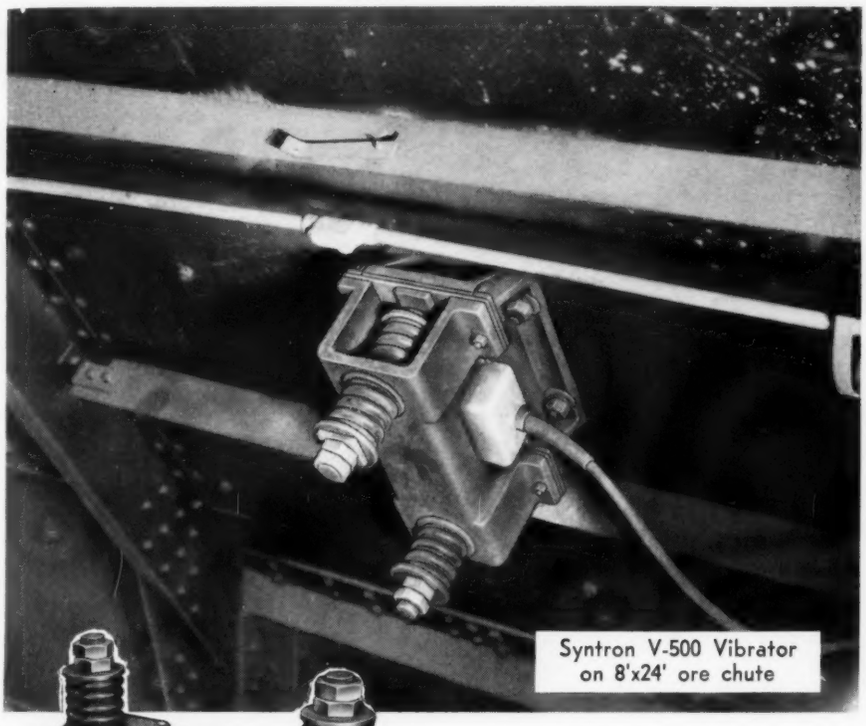
PATENT PENDING



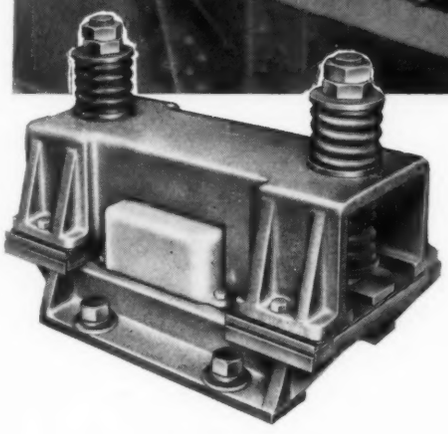
BLOOM ENGINEERING CO., INC.
837 W. North Avenue Pittsburgh 33, Pa.

SYNTRON *Pulsating Magnet*

BIN VIBRATORS



Syntron V-500 Vibrator on 8'x24' ore chute



Cut production costs —*keep materials flowing freely for higher production*

SYNTRON Bin Vibrators assure a constant, uninterrupted flow of coal, coke, limestone, sand, ore and other materials from storage and supply bins and hoppers to production lines—eliminate equipment damage from pounding and poking.

SYNTRON Electromagnetic Bin Vibrators set up waves of powerful, instantly controllable vibrations, 3600 per minute, to overcome arching, bridging or ratholing of even the most stubborn materials.

Vibration is instantly adjustable to suit conditions and material characteristics.

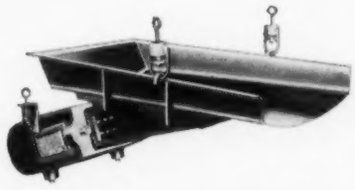
Electromagnetic design—fewer mechanical wearing parts means dependability, long life and low maintenance.

SYNTRON Bin Vibrators are available in sizes for every job. Easy to install, easy to operate, easy to maintain.

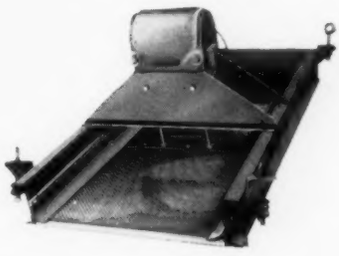
If your production is hampered by material sticking or plugging bins and hoppers call on SYNTRON.

Write for complete catalog data—FREE

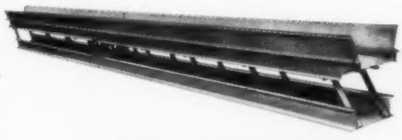
Other SYNTRON Equipment of proven dependable Quality



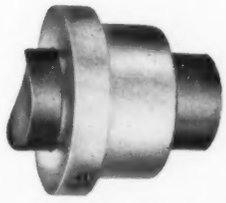
VIBRATORY FEEDERS



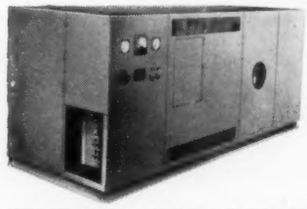
VIBRATING SCREENS



COUNTER BALANCED VIBRATING CONVEYORS



MECHANICAL SHAFT SEALS



SELENIUM AND SILICON POWER UNITS

SYNTRON COMPANY

699 Lexington Avenue — Homer City, Penna.

Johns-Manville Insulating Fire

put physical and thermal properties *in proper balance!*

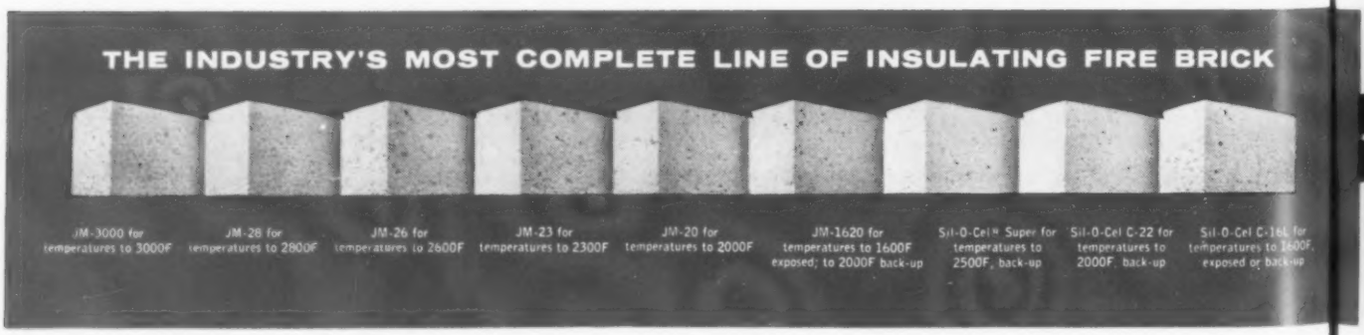
...provide essential high-temperature resistance and low conductivity...yet maintain high load-bearing strength with low spalling!

Only Johns-Manville's insulating fire brick family offers the right combination of properties to meet the diversified requirements of modern furnace construction.

Johns-Manville's nine different insulating fire brick mean you never have to settle for a brick that's nearly right! Instead you choose the one insulating fire brick or combination of brick that best meets your specific requirements for temperature resistance, load-bearing strength, conductivity and density.

Johns-Manville has two strategically located plants for the production of insulating fire brick: Lompoc, California and Zelienople, Pennsylvania. Insulating fire brick and other Refractory Products are available from the stocks of Authorized J-M distributors in key industrial areas.

For further information, call your nearest J-M representative. Or write for brochure IN-115A to Johns-Manville, Box 14, New York 16, N.Y. In Canada, Port Credit, Ontario.


THE INDUSTRY'S MOST COMPLETE LINE OF INSULATING FIRE BRICK
JM-3000 for temperatures to 3000F
JM-28 for temperatures to 2800F
JM-26 for temperatures to 2600F
JM-23 for temperatures to 2300F
JM-20 for temperatures to 2000F
JM-1620 for temperatures to 1600F exposed; to 2000F back-up
Sil-O-Cel® Super for temperatures to 2500F, back-up
Sil-O-Cel C-22 for temperatures to 2000F, back-up
Sil-O-Cel C-16L for temperatures to 1600F, exposed or back-up

JOHNS-MANVILLE JM PRODUCTS

Johns-Manville REFRACTORY and IN

INSULATING REFRACTORY PRODUCTS

NOW YOU WILL KNOW THEY ARE FROM GREAT LAKES CARBON

This New Emblem

is your assurance of carbon and graphite products—production engineered to the highest standards of quality.

The emblem is being introduced in all of our packaging — in electrode end protectors, nipple cartons, palletized anodes, palletized carbon brick, and drums of carbonaceous materials.

Watch for this emblem — it identifies products made to give you matchless performance.

ELECTRODE GLC DIVISION

GREAT LAKES CARBON CORPORATION

18 EAST 48TH STREET, NEW YORK 17, N.Y. OFFICES IN PRINCIPAL CITIES

GRAPHITE ELECTRODES • ANODES • AND SPECIALTIES

(*Continued from page 230*)

able media of the storage section. There the accumulated dirt is automatically wound into a compact roll for easy disposal. In the Rollotron resistance to air flow is uniform and constant and filter performance is always at optimum level regardless of job conditions.

The new Type B Rollotron is unique in its compactness, requiring minimum space in direction of air flow. This compact unit is easy to install and easy to maintain. Since it is not necessary to wash the plates water connections are not required and freezing problems are eliminated.

ROLL STRAIGHTENER

△ The largest machine of its type in the world, a Mackintosh-Hemphill Model A-5 rotary pipe straightener recently placed in operation has already brought to high-tolerance straightness and roundness more than 200,000 tons of pipe ranging in size from 4½ to 16 in. outside diameter.

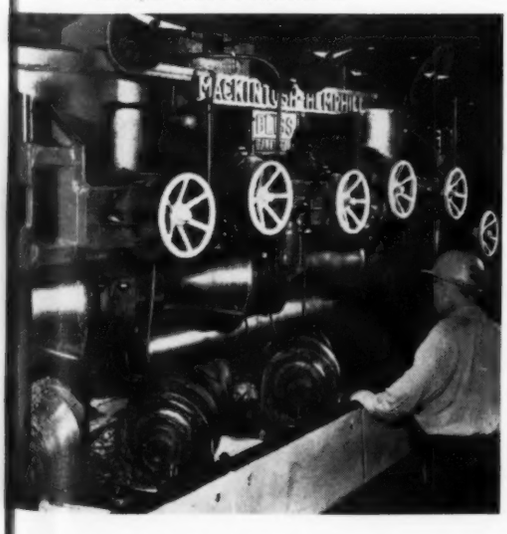
Installed in the East Coast plant of a major steel manufacturing company, the Model A-5 has easily handled every size and type of steel pipe produced by the firm's electric weld mill. It has been used on relatively light gage pipe—0.188-in. wall thickness—to heavy gage pipe with walls nearly one-half in. in thickness.

Normally run at speeds of 175 to 200 fpm to keep pace with the sizing mill which immediately precedes it, the huge straightener can handle pipe in 50-ft lengths at a maximum speed of 240 fpm.

The Model A-5's three-post construction, now standard on all Mackintosh-Hemphill straighteners, permits easy access to its three sets of cross rolls so that from the machine's front side these rolls can be adjusted quickly and locked to suit the pipe size exactly. The six rolls, each measuring 20 in. in diameter by 34 in. body length, were cast at Mackintosh-Hemphill's Pittsburgh, Pa., foundry. Despite the large tonnage of variously sized pipe already straightened on this machine, roll wear has been negligible.

Outstanding features of the straightener are its massive 85-ton main roll frame and its use of high-angle, gear-type flexible couplings on the spindles driving the six rolls from its two 100-hp main motors.

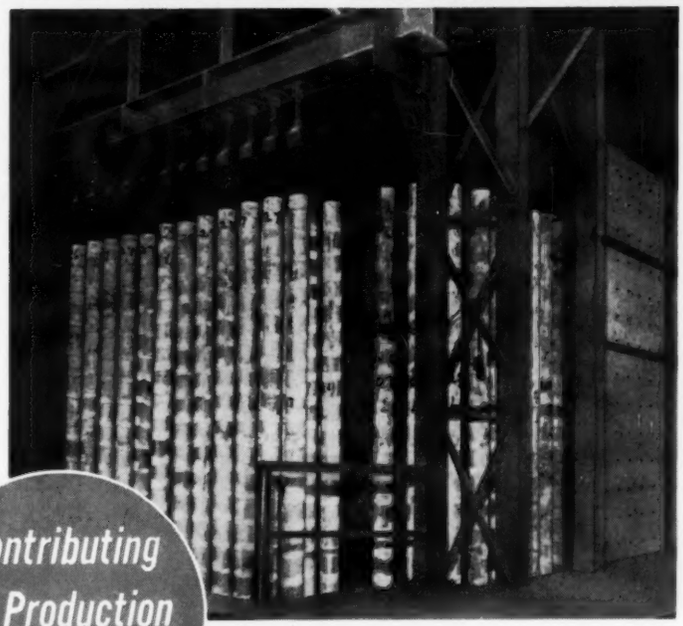
This rotary tube straightener, recently placed in operation, will handle pipe from 4½ to 16 in. outside diameter at speeds to 240 fpm. The unit produces high-tolerance straightness and perfect roundness.



HYDRAULIC FLUID

△ Socony Mobil Oil Co., Inc., has placed on the market a new line of

TITZEL STOPPER ROD DRYING OVENS



Contributing to Production Efficiency in the Steel Industry

FROM DESIGN TO INSTALLATION

- Jib and Casting Pit Cranes
- Hot Topping and Capping Cranes
- Jib, Pillar, Wall and Floor Traveling Cranes
- Cover Cranes for Steel and Aluminum Plants
- Button and Skull Burning Cranes for Scrap Yards
- Stopper Rod Drying Ovens
- Hydraulic Descaling Systems
- Mill Scale Handling Systems
- Palm Oil Systems
- Mill Dust Handling Systems
- Pneumatic and Mechanical Conveyors
- Designers and Manufacturers of Special Equipment

At the Cleveland Works Division of Jones & Laughlin Steel Corporation, Titzel Stopper Rod Drying Ovens and Titzel Jib Cranes were specially designed to meet specific requirements.

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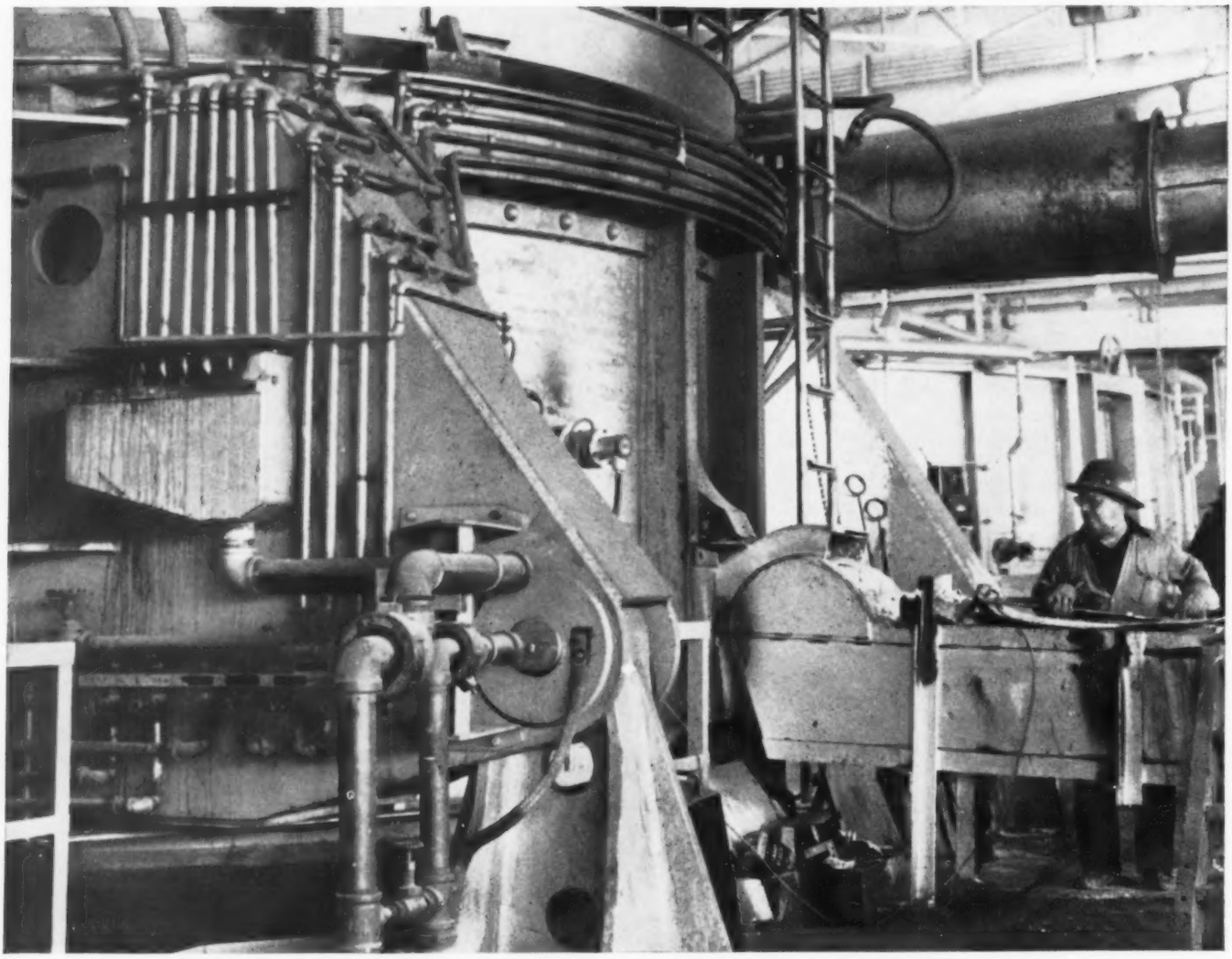
ALLIED COMPANY, TITZEL ENGINEERING & EQUIPMENT CO.



From the World's Largest Copper-Melting Electric Furnace

TOP QUALITY CASTINGS...ROCK BOTTOM COSTS

Whiting Hydro-Arc Electric Furnace at the Perth Amboy, N. J. plant of American Smelting and Refining Company pours a ton of copper every two minutes—24 hours a day, 7 days a week. Operating costs are competitive, even in this area of high-priced electric power.

Hydro-Arc offers you the *precise* temperature control that assures a top quality product—be it copper, iron, steel, or any other metal or material. You will save money, too, because continuous melting boosts production . . . top-charging reduces downtime . . . simplified design cuts maintenance costs . . . and Hydro-Arc costs less installed than other equipment of equal capacity. For prime melting or duplexing get the facts on Hydro-Arc.

SEND FOR NEW 8-PAGE BULLETIN EF-100 telling all about the electrode arm and clamp which floats on a cushion of air and which is clamped by a cushion of air. Booklet is fully illustrated. *Whiting Corporation, 15655 Lathrop Avenue, Harvey, Illinois.*

Member of the Foundry Equipment Manufacturers Association

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75TH YEAR

WHITING

FOUNDRY EQUIPMENT

MANUFACTURERS OF CRANES; TRAMBEAM HANDLING SYSTEMS; TRACKMOBILE; FOUNDRY, RAILROAD AND CHEMICAL PROCESSING EQUIPMENT

synthetic fire-resistant hydraulic fluids, Mobil Pyrogard Nos. 42, 43, 53 and 55, for use in heavy-duty installations involving radial-piston pumps and high pressures.

The new fluids are the result of several years of intensive field testing in hydraulic equipment. Together with Mobil Nyvac fluids (water-glycol type) and the Solvac fluids (water-emulsion type), the company now offers a complete line of fire-resistant hydraulic fluids for all types of equipment and kinds of service.

The Pyrogard fire-resistant fluids are made in four different viscosities and two different types. They will satisfy the requirements of high-pressure circuits and those installations having high fluid circulating temperatures.

Company engineers are equipped to analyze the requirements and to recommend the most economical fluid to meet the needs of a particular hydraulic system. This eliminates unnecessary expense for costly fluids not required by the equipment.

Through the correct selection of one of the three types of hydraulic fluids it is now possible to obtain maximum protection against the hazard of fire at the lowest possible cost.

LIMIT SWITCH

△ A new line of precision limit switches, designed for industrial applications where millions of operations are required, has been announced by Cutler-Hammer Inc.

The outstanding feature of the new switch is a unique contact mechanism, which provides greatly extended electrical and mechanical life as well as superior operating characteristics.

These small heavy-duty switches incorporate a movable contact assembly utilizing two compressed coil springs to provide a quick make-and break action. A leaf spring, carrying the contacts assures adequate contact pressure at all times; eliminates points of zero contact pressure and provides a nonteasing action even with an extremely slow operating motion. The contact carrier spring affords sufficient contact wipe to assure good electrical contact on low voltage.

Completely enclosed in a semi-dust tight molded phenolic case of great physical strength and high arc resisting capacity, the switch has an electrical rating of 600 volts.

A wide variety of operators, such as plunger, roller and cabinet door types are available for use in combination with the basic switch. These operators, with individual mounting variations, afford a high degree of versatility.

FURNACE LINE

△ Three strands of stainless steel tubing are simultaneously annealed in a continuous, automated furnace line designed and built by Selas Corp. of America.

The six-barrel-furnace line, only 15½ ft in over-all length, can accommodate tubing from ⅝ in. to 5 in. O.D. Rated production is 1985 lb per hr (based on 2 in. O.D. tubing at 3.72 fpm). Automatic temperature control is in three zones, to deliver tubing at 2100 F to the quench located at discharge end. Each barrel unit is equipped with five gas-fired Duradiant burners.

Although exposed to high ambient temperatures, this cab is easily kept at 80°-85° F. It means safer and better working conditions and improved production.

Cranes and Pulpits Air Conditioned by LINTERN in Modernization at "the Exciting New J & L"

Eleven years ago, in 1948, the first installation of Lintern Air Conditioners was made for the Cleveland Works of Jones & Laughlin Steel Corporation. It consisted of air conditioning the cab on a soaking pit crane.

In the recent Cleveland Works expansion and modernization program, two additional soaking pit cranes were installed and Lintern Equipment again selected for air conditioning the cabs.

Also, in conjunction with the new 77" Strip Mill facilities, five pulpits — outfitted with Lintern Equipment — were added to the list of air conditioned units.

Ease of servicing the condenser from one side only and compactness — resulting in use of minimum space — are two of the chief factors responsible for the wide acceptance of Lintern Air Conditioning Equipment.

Ask for Bulletin AC-573.

Larco, inc.
DISTRIBUTOR OF LINTERN CORPORATION PRODUCTS
ROUTE 20 EAST • PAINESVILLE, OHIO

CONTROL VALVES

△ The new ½-in. Poppet Pilot "B Type" single and double solenoid operated control valves, just introduced by Hunt Valve Co., are said to combine rugged construction, compact design and zero leakage. The company emphasizes these valves have full ½-in. flow (257 cfm at 100 psig), compared with ⅜-in. valves tapped ½ in. but having only ⅜ in. flow; or ¾-in. valves tapped ½ in. but selling at the ¾ in. price.

Housings of these valves are aluminum castings. The valve chambers or compartments in the straight through bore are formed with metal spacers, held rigidly in metal-to-metal end abutment, that position the packings accurately, and support them on both the inside and outside diameters without placing them under mechanical pressure. Flow is through the hollow, radially ported, stainless steel plunger and out the connected piping, assuring long maintenance-free operation.

Pilot operation of these valves, instead of applying the force of the solenoid directly against the valve plunger, employs fluid pressure to operate the valve, permitting the use of smaller, shorter stroke solenoids than would otherwise be required.

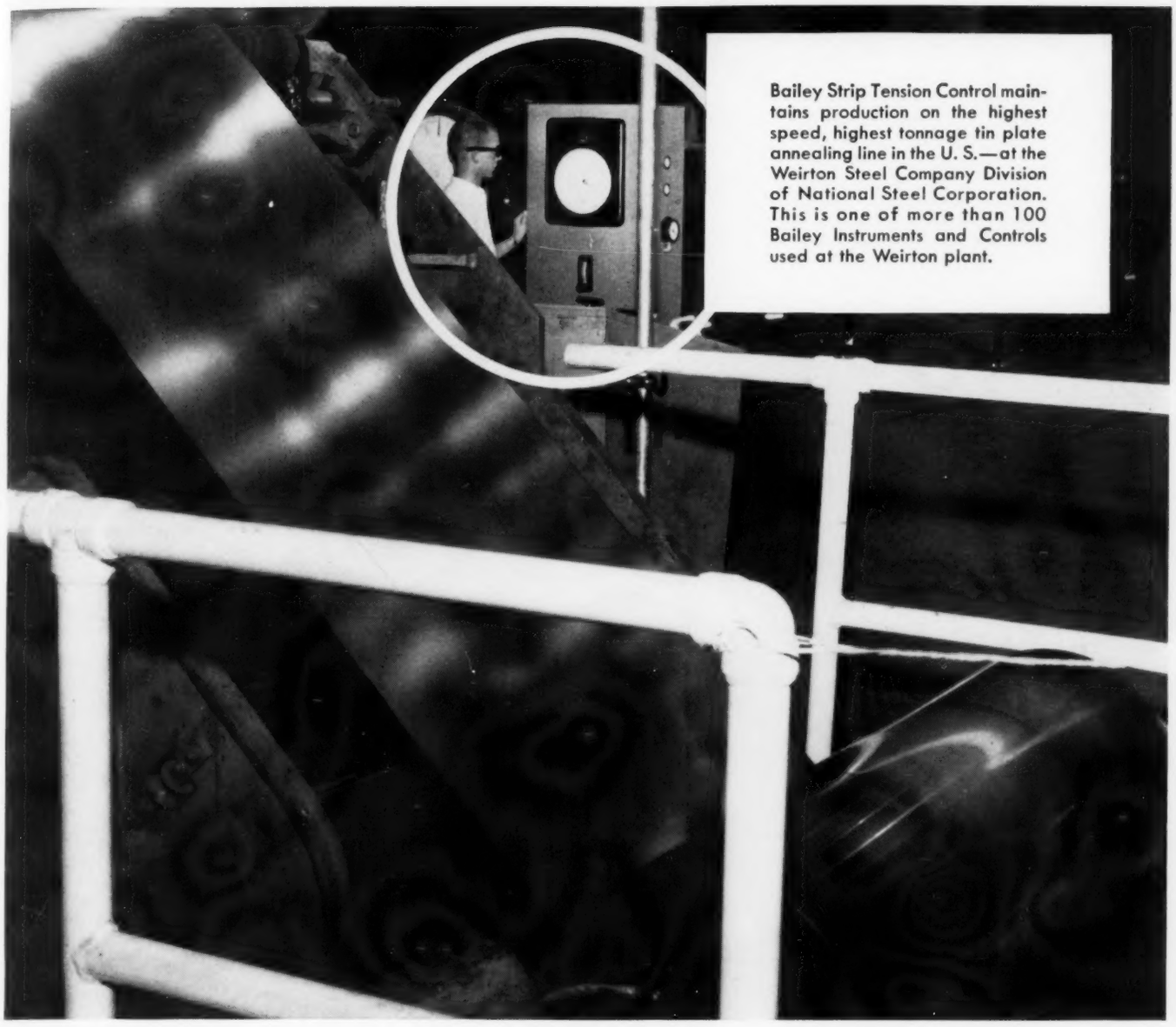
Book Reviews

"Advanced Mechanics of Fluids," edited by Hunter Rouse, has recently been published by John Wiley & Sons, Inc., 440 Fourth Ave., New York 16, N. Y. The book contains 444 pages, 6 x 9 in., is cloth bound, and sells for $9.75. The book was prepared by the members of the senior staff of the Institute of Hydraulic Research at the State University of Iowa under the guidance of the editor. This book is a sequel to "Elementary Mechanics of Fluids" and introductory knowledge is presumed with full attention being given to broadening and deepening analytical ability and understanding. The goal of the work is the development of research methods and the theoretical approach is given primary emphasis, yet the presentation stresses that experience must ever remain in control of scientific progress. It is a combination of text, examples, problems and answers. Numerous line drawings, equations, charts and graphs are used throughout the book.

"Guide to the Literature of Mathematics and Physics," by Nathan Grier Parke III has recently been published by Dover Publications, Inc., 920 Broadway, New York 10, N. Y. The book contains 436 pages, 5 x 8 in., is bound in heavy paper, and sells for $2.49. The book contains an up-to-date listing of agencies and individuals who are engaged in Russian translation programs. The book lists more than 5500 key works under 120 subjects headings such as projective geometry, geometric optics and cosmic rays; titles are carefully cross-referenced and the subject classifications are based on those used by *Mathematical Reviews;* whenever a foreign language title appears, any translations are also listed; if there is no English translation of a Russian work, for example, the Guide will tell you if there is one in German.

"Mathematics for Industry," by S. E. Rusinoff (revised edition) has

(*Please turn to page 243*)



Bailey Strip Tension Control maintains production on the highest speed, highest tonnage tin plate annealing line in the U. S.—at the Weirton Steel Company Division of National Steel Corporation. This is one of more than 100 Bailey Instruments and Controls used at the Weirton plant.

Strip keeps rolling when Bailey keeps an eye on it

Installing Bailey Strip Tension Control will cost you far less than a single strip breakage in a furnace due to poor tension control . . . and it's the surest way of ending tension problems.

Strip tension at speeds up to 2000 feet per minute is pre-set, controlled, and recorded by this unique system. Bailey S.T.C. eliminates undue instantaneous strains through natural 'cushioning' of pneumatic control. It helps maintain strip flatness during finishing operation by minimizing slack formations, and it simplifies strip tracking by holding tension within allowable limits.

If you roll strip, see your Bailey Engineer about Strip Tension Control, or write the Iron and Steel Division for more information.

S114-1

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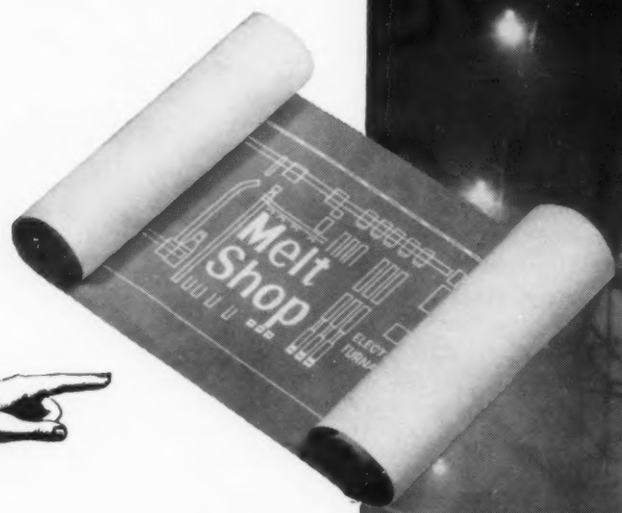
Tapping 10-ton Heroult Electric Furnace at the Colton, California, Plant of the Griffin Wheel Company.



Modernization?

Begin it here

The Heroult Electric Furnace will help you produce better-quality steel . . . faster . . . and more economically. Why not put one in now and improve your competitive position with a thoroughly modern melt shop?

The Heroult is a 100% mechanically operated electric furnace. All movements are handled by motor-driven gear mechanism. Your own maintenance man can easily keep this modern electric furnace performing efficiently with minimum service.

1½ to over 200 tons capacity! In addition to making a full range of foundry sizes—from 1½-ton capacity—Heroult Electric Furnaces are also available in large sizes—with capacities in excess of 200 tons. You can select door-charge or top-charge models—with gantry—or swing-top moving roofs. Special induction stirring equipment, duplexing arrangements, and non-ferrous furnaces also can be furnished.

Complete melt shop installation—American Bridge is prepared to furnish an entire new melt shop tailored to your specific requirements. This service includes the design and construction of a modern melt shop building—from the foundation up—and installation of all machinery and equipment necessary for the efficient production of top-quality steel. Our engineers are prepared to discuss your requirements.

This 32-page catalog will help you determine how Heroult Electric Furnaces can improve your operation and enable you to make better-quality steels; tells you when and where an electric furnace is logical; gives types, sizes, capacities and ratings. For your free copy, get in touch with any of the offices listed below or write direct to Pittsburgh.

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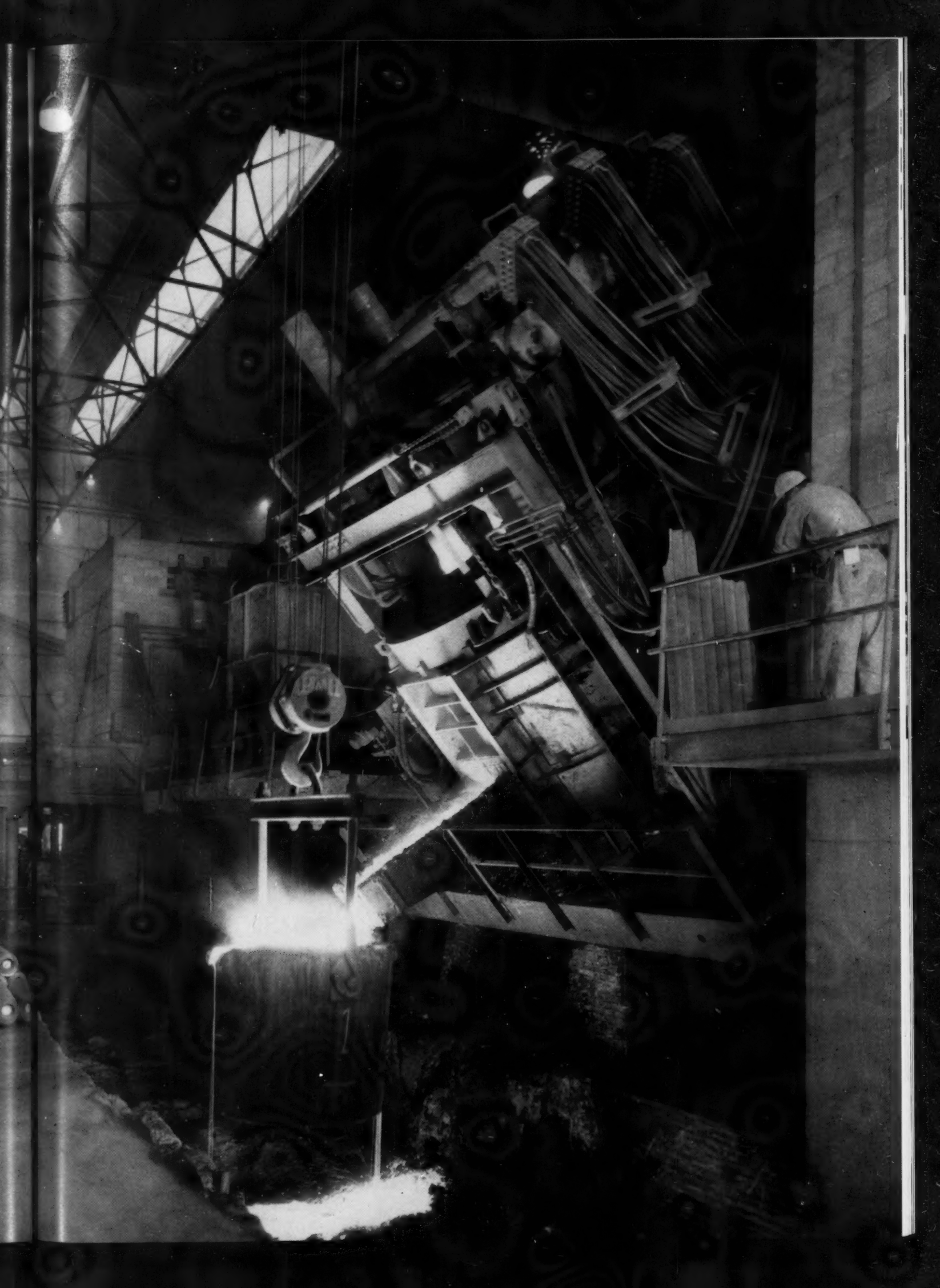
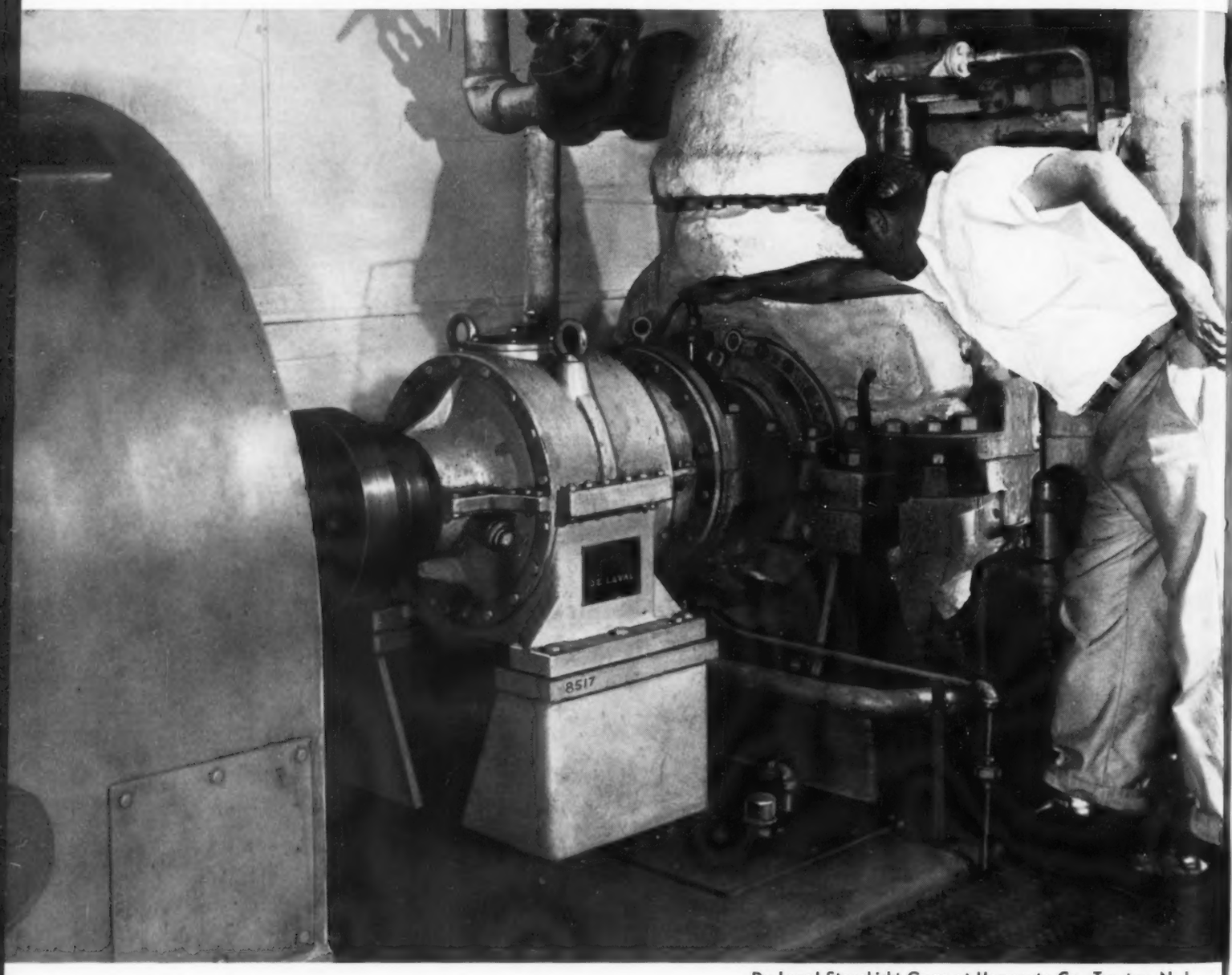


Creative Engineering by DE LAVAL



De Laval-Stoeckicht Gear at Homasote Co., Trenton, N. J.

2800 Horsepower in a 22" package!

That compact "package" you see in the center of the picture above is a De Laval-Stoeckicht Planetary Gear. Developed by W. G. Stoeckicht in Germany, this gear has been proved in hundreds of European installations. It is capable of transmitting 2800 horsepower from the steam turbine at the right to the generator at the left. It weighs only 900 pounds. A conventional gear for this service would weigh 4000 pounds. And the De Laval-Stoeckicht gear takes up less than half the space of a conventional gear. This is another example of how De Laval *creative engineering* plus precision manufacturing and highest quality control assure lasting customer satisfaction.

DL 440

DE LAVAL *Steam Turbine Company*

870 Nottingham Way, Trenton 2, New Jersey

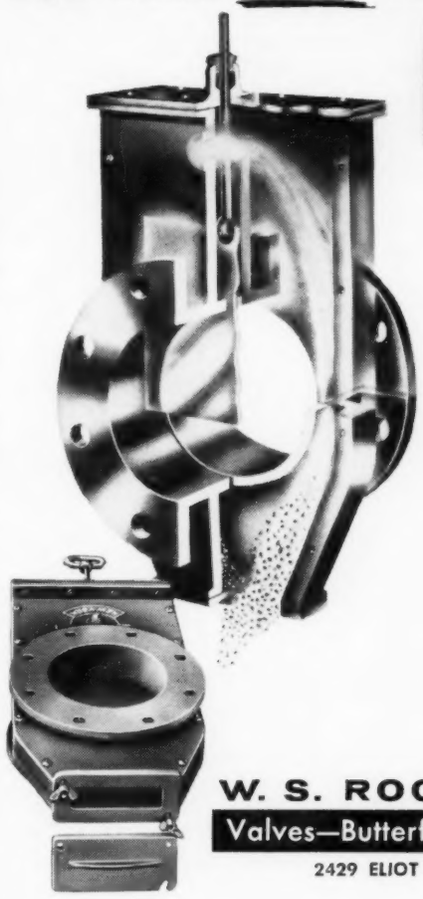
(*Continued from page 238*)

recently been published by the American Technical Society, 848 East 58th St., Chicago 37, Ill. The book contains 565 pages, 5½ x 8½ in., is cloth bound, and sells for $6.25. This is a functional presentation of the mathematics most often needed in engineering and machine shops. The book contains hundreds of problems dealing with screw threads, gears, strength of materials, which apply to practical shop problems, and many other applications. Important additions to this revised edition are chapters on the use of graphs in the solution of engineering problems, the computation of automatic controls for automation, and problems in inspection and quality control.

"The Determination of Nitrogen in Steel" (BISRA Special Report No. 62), has recently been published by The Iron and Steel Institute, 4 Grosvenor Gardens, London, S. W. 1, England. The book contains 146 pages, 8½ x 11 in., is cloth bound, and sells for 37s, 6 d. The book is divided into two parts: Part 1, chemical determination of nitrogen in steel; part II, the vacuum-fusion method. The appendixes record much additional information relevant to the work carried out and the conclusions reached, obtained during the course of this study. Also included is the record of an investigation of nitrogen determination in ferro-chromium which was also studied. Numerous tables are contained as part of the book and six illustrations are included to round out the report.

"A Simplified Technique of Control System Engineering," by G. K. Tucker and D. M. Wills has recently been published by the Minneapolis-Honeywell Regulator Co., Brown Instruments Div., Philadelphia, Pa. The book contains 303 pages, 6 x 9 in., is cloth bound and sells for $5. The work presents graphical methods of understanding and improving process control. The practical control system is the subject: how it is designed to work, how to find out about its performance, how to make it work better. The book points out what a control system analysis can do and how one might go about making one; it is a guide to working out a control sys-

You need never remove



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For fluids, air or gases containing solids or for free flowing granular materials that clog or jam conventional valves—Kwikleen is the answer.

It permits 100 per cent flow in full open position and quick shut-off manually or mechanically. Easily, quickly cleaned by removing bottom plates. The valve need not be removed from the line. Sediment drops out or can be blown or flushed out by air or water.

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Companion instruments—using an identical null-balance-vector "heart"—include differential pressure, temperature and pressure transmitters . . . ratio, totalizing, multiplying, squaring and square - root - extracting relays. Many parts are interchangeable among the instruments in this "family". Besides reducing spare parts inventory, the similarity of components simplifies the task of training personnel.

Let a Republic engineer show you how these instruments can help to achieve accurate, efficient, dependable control systems. Republic Sales Offices are located in principal cities throughout the U.S.A. and Canada.

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Manufacturers of electronic and pneumatic instrument and control systems for utility, process and industrial applications.

tem of one's own; it tells one what kind of numbers he must have to describe the system, how to get them as quickly and easily as possible, how to use the information in finding out what control performance will be, and how to interpret and use the results of analysis. It contains answers to help in selecting instrumentation; in comparing different control systems for the same process without having to install them; in finding those changes in process equipment or arrangements which will improve control performance; and in telling whether a change will give enough improvement to be worth its cost. Numerous line drawings, tables, equations, charts, etc. are used to illustrate the text.

"The Atom and The Energy Revolution," by Norman Lansdell has recently been published by the Philosophical Library, Inc., 15 East 40th St., New York 16, N. Y. The book contains 200 pages, 6 x 9 in., is cloth bound, and sells for $6. Subjects discussed are: the atom, its energy and methods of releasing it; material sources of atomic energy; its exploitation by separate countries and by international bodies; and its impact upon the world as a whole. Several photographs are included as illustrations, and a glossary is contained at the end of the book for reference.

"ASTMA Standards 1958-Part 2, Non-Ferrous Metals Specifications (except Test Methods), Electrical Materials," has recently been published by the American Society for Testing Materials, 1916 Race St., Philadelphia, 3, Pa. The book contains 251 standards in 1386 pages, 6 x 9 in., is cloth bound, and sells for $10. Covered in this volume are: aluminum and aluminum-base alloys; aluminum wire, rods, and standard conductors for electrical purposes; magnesium and magnesium alloys; zinc and zinc alloys; copper; copper and copper alloy wire and conductors; copper and copper alloy castings; copper alloy wire rods, bars, shapes; copper alloy pipe and tubes; copper and copper alloy plate, sheet, strip; die castings; lead and lead alloys; nickel and nickel alloys; lead- and tin-base alloys; titanium; solder and bearing metal; zinc; deoxidizers; electrical-heating and resistance alloys; metal powder products; electrical contact materials; electrodeposited coatings; materials for electron tubes, electronic devices and lamps.

"The Unfired Pressure Vessel Code Simplified," by Robert Chuse (latest edition) is now available and may be obtained from the author, P.O. Box 91, Leonia, N. J., at $6.50 per copy, single charts at $1.00 each. The 1958 edition contains 48 pages, is a simplified analysis of the ASME Unfired Pressure Vessel Code. The book includes simplified charts for internal and external pressure, shell thickness, flanged and dished head thickness, flat head thickness, flat cover plate thickness and openings and reinforcements. Also contained are new charts on external pressure on heads, stamping, head and shell volumes, welding qualification positions, new information on magnetic particles and penetrating oil tests, plate identification, nonidentified material, articles on Canadian pressure vessel requirements, the Code symbol and certificate-procedure to follow to obtain them, and welded repair procedure.

"Warmebehandlung der Eisenwerkstoffe" (The Heat-treatment of Ferrous Materials), by H. Ruhfus, 483 text pages, 6 x 9 in., 384 illustrations, 39 tables was published in 1958 by Verlag Stahleisen, Dusseldorf, Germany, 52 German Marks (about $13).

This excellent book combines theory with successful practice. Where theory is too complicated for practical use, charts based on experience are given, for instance, heating time and holding time as a function of carbon equivalent and size of work. It discusses heat-treatment from the beginning (making of cast iron and steel) through all operations to the testing of heat-treated material for physical properties, accuracy of dimensions, and freedom from flaws. The book is up-to-date. New heat-treating processes, originating in France and in Russia are described in detail. Projecting new plants, cost-accounting, organization, and safety rules are given. (Reviewed by W. Trinks.)

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Electric resistance heating for semi-finished and bar mill products

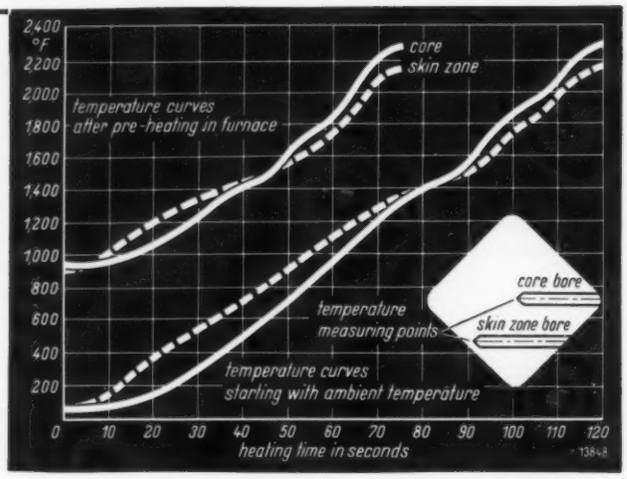
Bochumer Verein of Bochum, W. Germany, has developed a method permitting electric resistance heating of billets, sheet bars and bars in semi or fully automatic operation. SCHLOEMANN holds exclusive manufacturing rights for this method.

The problem

For a long time past, it has been known that heating up to rolling or heat-treating temperatures by electrical resistance offers great advantages compared with heating in a pusher-type furnace. Until recently, however, it has not been possible to utilize this method in practice: The billets, including the ends, must be heated evenly—and this requires the application of current to the end faces. But these faces, having been cut by shear or saw have irregular surfaces which allow contact to be made only on the high spots which tends to melt causing rapid deterioration of the contact makers.

The solution

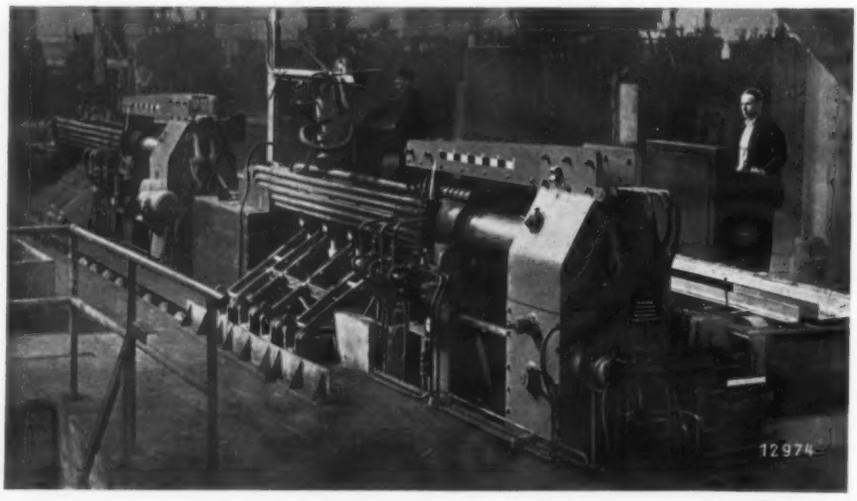
With the new method, overheating is avoided by spraying water on the ends of the billets and the contact faces transmitting the heating current. Any arcs that might occur are immediately suppressed by an automatically operating current limiting choke coil. The contact maker carries a water-cooled jacket.



Temperatures during resistance heating, measured in skin zone and core of structural steel. Steel rather slowly heated with regard to measuring conditions.

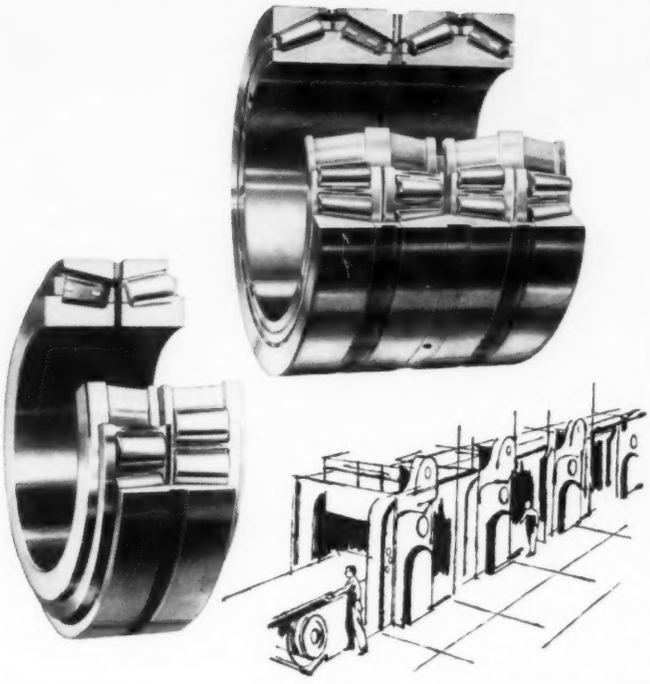
Advantages

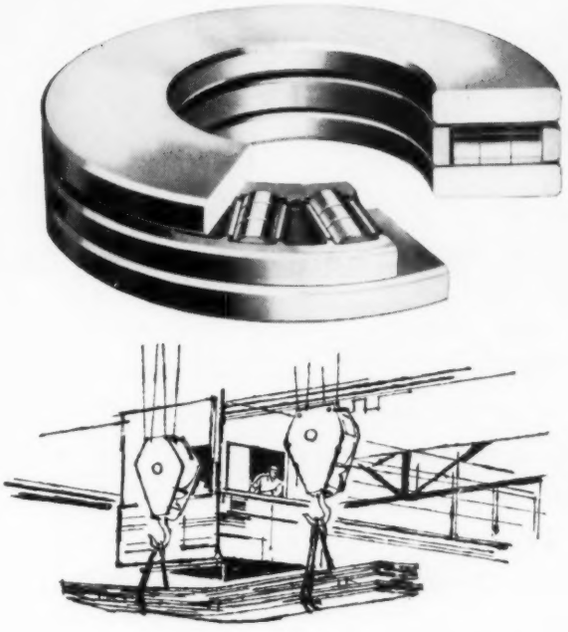
The time for heating is considerably lessened (see temperature curves). Coarsening of the grain is avoided, the billets being exposed only for a short period to temperatures over Ac3. Scaling is reduced from about 2 to 4 per cent to about 0.5 to 1.5 per cent. Furthermore, no decarburization occurs in the skin zone. Contrary to heating in the pusher-type furnace, the interior temperature of the billets is higher than the surface temperature. The effective heat increases to at least 60 per cent and is thus higher than with pusher-type furnaces.

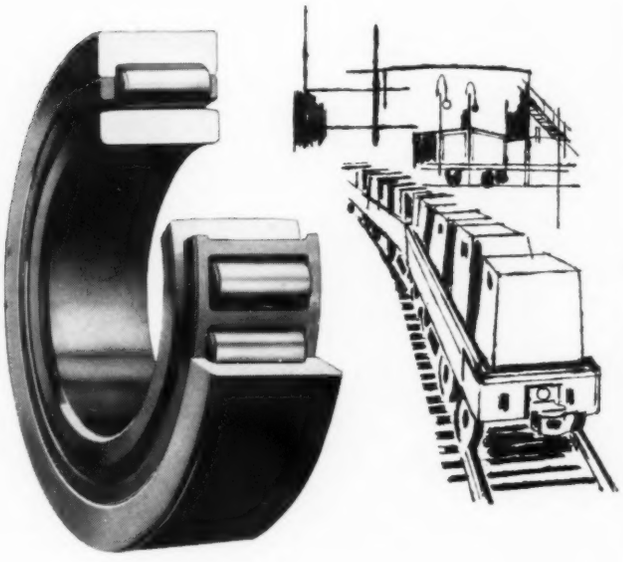


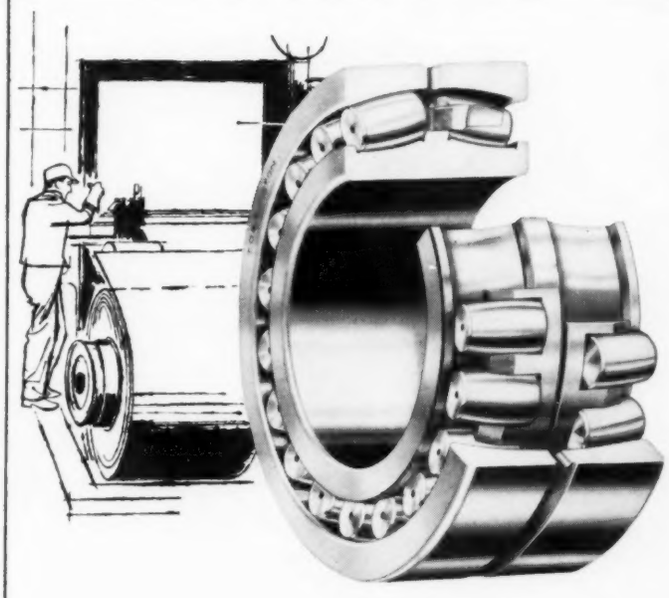
The billets which have been evenly pre-heated to 932° F are automatically tilted on to the roller table by the two units after 35 seconds at a surface temperature of about 1,742° F.

FELLER ENGINEERING CO., 1161 EMPIRE BUILDING, PITTSBURGH 22, PA.









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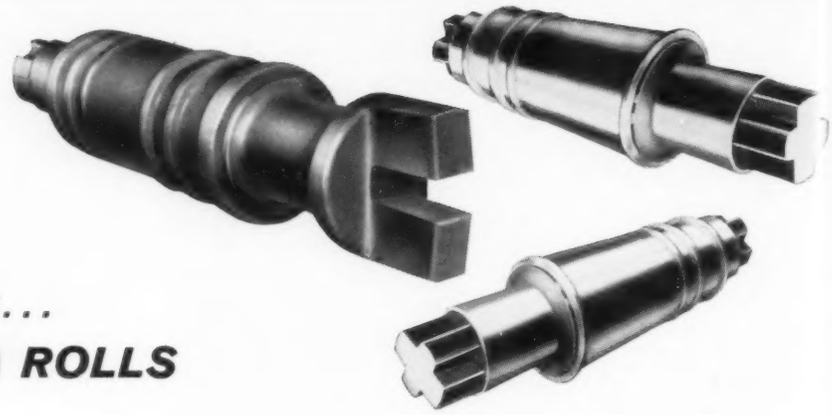

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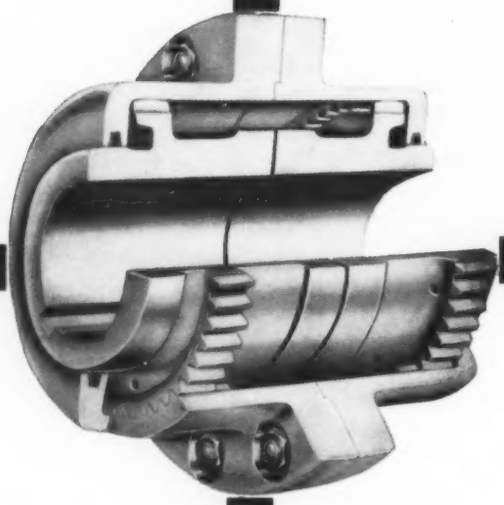

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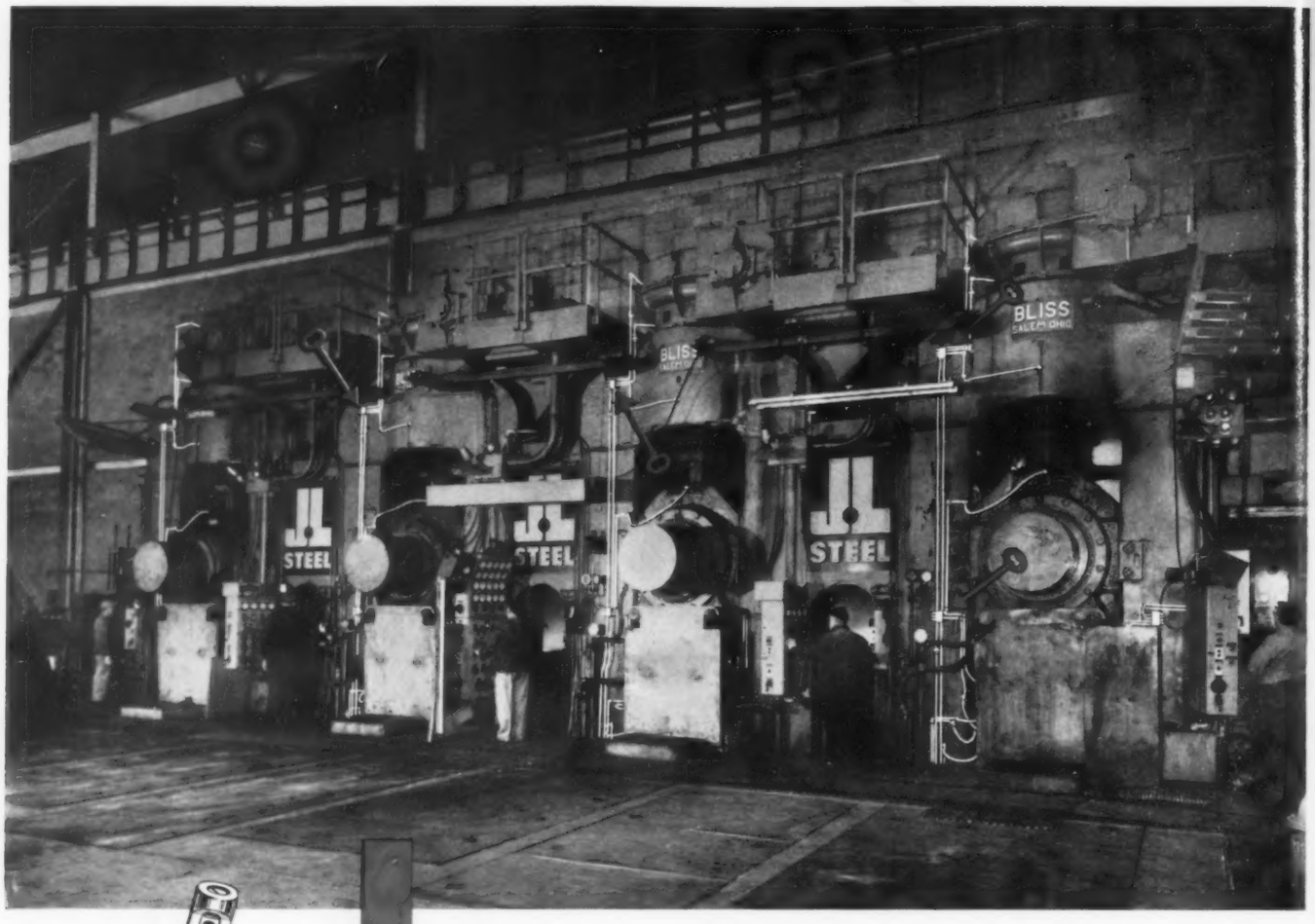

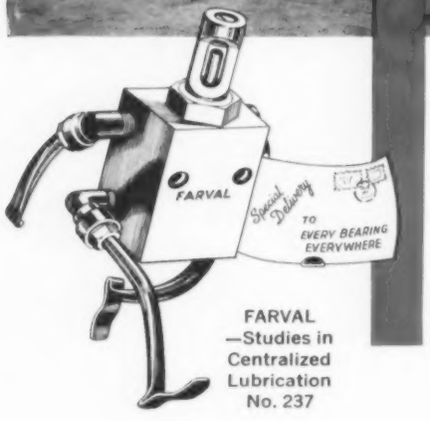

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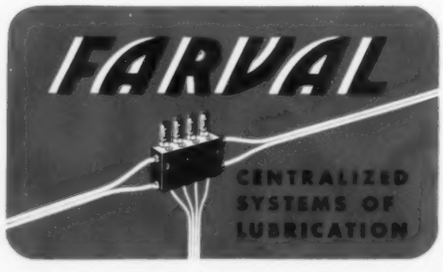
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